In Addition Afterschool Mathematics Program Principles, Practice, and Pitfalls

by Judith McVarish and
Patricia Birkmeier

Studio in a School

Afterschool math hours are most often spent on homework help, tutoring, drill, and test-preparation with instructors who may not be certified teachers or mathematics educators (National Research Council, 2001; National Council of Teachers of Mathematics, 2000). While such "extra math help" may be of value, it is unreasonable to expect students to enjoy learning experiences based on workbook-style exercises.

The In Addition project, a program of New York University's Steinhardt School of Education, re-envisions afterschool math. We seek to engage children in learning mathematics that is about curiosity, questions, and intrigue, incorporating inquiry-based mathematical learning into the urban community. This paper reflects on the program's founding principles and on what we have learned in our first year of implementation: how we worked to shape our daily practice around inquiry-based math learning in the context of the urban community and the pitfalls we encountered along the way.

Classroom Math Learning

The reform movement in mathematics education (National Research Council, 1989; National Council of Teachers of Mathematics, 1991, 2000) provides a clear vision of mathematical learning. It includes creating learning opportunities that engage students so that they both feel confident in their ability to solve mathematical problems and recognize mathematics as relevant in their everyday lives. The shifts being called for include building mathematical communities where students present, question, and defend ideas and thinking, with an emphasis on logic, problem solving, and reasoning over memorization, procedural thinking, and right answers.

The National Council of Teachers of Mathematics (NCTM, 2000) posits that mathematical understanding increases when students are engaged in real-life, problem-based learning. The

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National Research Council (NRC, 2001) recommends providing students with opportunities to investigate ideas collaboratively as a community of learners in order to discover multiple strategies that lead to a deeper understanding of mathematics. Collaborative questioning and conversations can also contribute to a sense of shared learning that reduces the competitive inclinations often associated with a traditional learning environment. Steven Levy (1996) suggests, "Asking questions promotes an interest in the 'Other,' acting as a balance to the self-absorption and the self-centeredness that so pervades our culture" (p. 37).

Many elementary schools are not afforded such learning "luxury." "Surveys of U.S. teachers have consistently shown that nearly all their instructional time is structured around textbooks or other commercially produced materials, even though teachers vary substantially in the extent to which they follow a book's organization and suggested activities" (NRC, 2001, p. 36). In responding to a 1996 National Assessment of Educational Progress (NAEP) mathematics assessment, teachers reported that fourth graders were usually tested in mathematics once or twice a month. About one-third of the children took tests once or twice a week, even though more frequent testing was associated with lower achievement (NRC, 2001, p. 40). Over 90 percent of these teachers reported that they gave considerable emphasis to facts, concepts, skills, and procedures; only 52 percent focused on reasoning processes and even fewer, 30 percent, on communication.

Often teachers explain the disparity between mathematics reform goals and the realities of the classroom as "not having enough time" to help students discover mathematics. Sometimes curriculum and testing pressures, fueled by an ever-increasing mantra of accountability based on standardized tests (Eisner, 2003), place rigid teaching and learning expectations on teachers and students. While rigid adherence to curriculum is meant to help students achieve higher test scores, national results show that this emphasis is not working (Eisner, 2002). The cost, however, is a loss of joy about learning mathematics that not only decreases learning potential, but also produces mathematics anxiety and frequently leaves students with a view that mathematics is a discrete set of skills with no relevance to their lives. Mathematics learning then becomes rote and compliant memorization of facts and procedures in which students merely plug in a formula to get the desired answer to an isolated, irrelevant question.

What would it look like if the afterschool hours were used to tie students' interest in their community with mathematics learning?

Art: *Studio in a School*

The Need for Afterschool Programs

According to the Carnegie Council on Adolescent Development (1992), over 17,000 organizations in the U.S. provide afterschool programs to children. These include organizations such as Girl and Boy Scouts, Boys and Girls Clubs, YMCAs, and various community-based programs. These programs traditionally focus on sports and recreation, homework, and childcare. Some programs have a more specific focus, such as remedial tutoring in basic skills to improve test scores or enrichment activities for gifted and talented students (Carnegie Council on Adolescent Development, 1992).

With their many different foci, afterschool programs have one thing in common: All are intended to keep

children safe and supervised while their parents are at work. Eight million children ages 5–14 are in need of care during the afterschool hours. Unsupervised children are more likely than supervised children to use drugs or to become parents. The juvenile crime rate triples between 3:00 and 6:00 PM, and young people are most likely to be victims of a violent crime committed by a non-family member during this part of the day (National Institute on Out-of-School Time, 2000).

Not only are children who attend an afterschool program kept safe, but they also build social skills, enhance peer relationships, improve their grades, and suffer from fewer behavior problems in school and at home than students who do not attend. Vandell and Posner (1999) found that afterschool activities can have emotional benefits for children. They concluded that children who have more social connections during the afterschool hours are better adjusted than those who do not. Such children receive better grades and demonstrate stronger work habits (Vandell & Posner, 1999). Teachers and principals report that students become more cooperative and learn to handle conflicts more effectively when they are involved in a structured activity after school (National Institute on Out-of-School Time, 2000).

A typical day in the In Addition program last year began with a daily graphing question followed by discussion. For example, the following sentence was presented on a magnetic board: "I would rather travel by . . . car, bike, train, airplane, boat, motorcycle, subway, bus, or other." Art: *Studio in a School*

The In Addition program was created not only to meet the general need for afterschool programming but more specifically to help children both to build their mathematics problem-solving abilities and to feel connected to their environment. What would it look like if the afterschool hours were used to tie students' interest in their community with mathematics learning?

How the In Addition Project Works

Context

In Addition is situated in a public elementary school in the Lower East Side of Manhattan, a neighborhood with one of the highest concentrations of immigrants in the nation. The school's population of 529 students consists of Asian, Black, Hispanic, American Indian, and White students. The majority, 57 percent, are Hispanic; Black and Asian students comprise 35 percent of the school's population. From this population, we randomly selected 21 out of 46 interested students through a lottery system, taking seven students each from the third, fourth, and fifth grades. We did not limit the opportunity to distinct populations such as gifted or at-risk students, because we wanted to ensure a heterogeneous group. The only criterion for acceptance was a commitment to attend two hours a day, four days a week, from September to May.

The In Addition project team is comprised of an associate professor and a graduate student from New York University specializing in mathematics education, as well as an environmental education consultant. Teaching responsibilities are shared among them.

Combining the recommendations of the NRC and the NCTM, In Addition aims to facilitate the teaching and learning of mathematics outside of classroom constraints such as high-stakes testing and grades. Though basic math skills are important, we are committed to studying the experience of children who learn mathematics when the motivation to learn comes from within; when the quest to satisfy curiosity is honored; when ideas can evolve and percolate and bring

forth insight, wonder, and understanding; when everyone—children, teachers, parents, and community members—is involved. The program uses students' questions and interests to guide them in mathematical investigations linked to their neighborhood. Students help each other become more aware of and connected to their community by examining their world through the lenses of their diverse backgrounds. Parent participation, through workshops and retreats, provides both a support system for students and links among home, school, and community.

A typical day in the In Addition program last year began with a daily graphing question followed by discussion. For example, the following sentence was presented on a magnetic board: "I would rather travel by . . . car, bike, train, airplane, boat, motorcycle, subway, bus, or other." Students placed tiles with their initials on them in their chosen category to create a graph on the magnet board. The ensuing discussion involved issues of time, destination, budgets, companions, experience, and purpose of travel. The graphing discussion was followed with a literature read-aloud. Students then began working on their small-group projects. The Bridge Group was building a bridge, using paper and masking tape, that would hold a five-pound weight; the People and Cultures Group was using the Internet to map migration patterns of people in their community from their original homelands; the Water Group was analyzing survey results on student water usage; and the TV Group was figuring out how to represent their data results from previous interviews. We closed the day by discussing the groups' progress, challenges, and successes, as well as identifying new questions that were emerging for investigation.

In Addition Afterschool Learning Principles

Our beliefs about how children learn, powered by our experiences as mathematics educators and by ideas from the literature, provided the framework on which we shaped our ideas about integrating inquiry-based math learning with the urban community. The result was the In Addition Afterschool Learning Principles:

1. Children learn when they are engaged and fascinated.
2. Children learn when they share their ideas and think with others in a community of learning.
3. Children learn when their learning is embedded in themselves, their homes, and their communities.

1. Children learn when they are engaged and fascinated.

Encouraging children to explore things they wonder about and to think about new questions creates a cycle of excitement. Instead of being drudgery, learning becomes an enjoyable, satisfying experience that begs to be repeated over and over again in a variety of new circumstances (Dewey, 1916). We offered children a variety of opportunities to explore their urban neighborhood: its bridges, parks, rivers, cultural communities, historical landmarks, and local businesses. Their investigations included interviews, surveys, observations, experiments, and mapping. On bridge field trips the children became curious about why people walked across the bridge, which led to a series of bridge interviews.

The following journal entry represents one student's learning experience:

> *Student Journal Entry (1/14/2003)*
>
> We had a lot of fun doing our interviews. We had five questions that we wanted to ask people on the bridges. I held the video camera and Kayla asked the questions to the people passing by. It was hard to get them to stop, though. Some people actually ignored us when we tried talking to them. Now, that's just rude! Most of the people we did talk to were visiting and it was their first time walking over the Brooklyn Bridge. One person said that they came all the way from Italy to see New York City. And one man said that he crosses the bridge every day to go to work. That bridge is so long and it was so cold out there, I would never want to cross it every day.

The Bridge Group used these interviews to gain insight into how people use the city's bridges. New questions arose through this investigation, as the students began to discuss the likelihood that their classmates had ever walked across the bridge. Such an investigation using data collection and analysis is closely aligned with the NCTM Data Analysis and Probability Standard (2000) recommending that students develop and evaluate inferences and predictions based on data.

2. Children learn when they share their ideas and think with others in a community of learning.

Building urban learning communities of trust (Ennis & McCauley, 2002; Wayne, 2002) leads to socially and experientially constructed learning that enhances people's ability to discuss ideas, develop reasoning

capabilities, and establish a habit of collaborative problem posing and solving. A learning environment in which respect for the thinking of all is the norm allows students to think about things from new perspectives. By pushing to ideas and solutions they had not thought about before, children and adults develop self-confidence and cultivate a sense that problems are not insurmountable.

Our main strategy for building such a community of trust was a weekly mathematics investigation involving active dialogue and debate. Over time, as students shared their various solutions and problem-solving strategies, they began to see the value in multiple perspectives and to appreciate the thinking of their peers.

The following excerpt written by Tricia, the teacher, shows the students in this type of exchange while working on "The Three Coin Problem." Students pretended that they had three coins in their pocket: one dime, one nickel, and one penny. They reached into their pocket, recorded the type of coin they pulled out, and then replaced it in their pocket. This was repeated twice. Student groups then had to determine how many different three-coin combinations were possible. (Student names have been changed in all excerpts.)

Research Field Log 2/6/2003

The discussion began with Rosa's group. Kayla and Rosa came to the board and said that they had 21 combinations. I asked the class to take a couple of minutes to really look at their work and raise their hand when they understood the pattern this group used to find all possible combinations. Kenny explained that they had opposites following one another, but he noticed that the pattern doesn't continue in some places. Rosa and Kayla said that they didn't realize that they used a pattern. Beth and Jenny commented that they used "trees" to organize their work and they also found 21 combinations.

José and James explained that they got 27 combinations. The students began to question José. Rosa wanted to know the original order in which he wrote the combinations down. She said that his pattern was visible going down but not across. José explained that he started with dime, dime, dime (DDD) and then moved to DDN, DDP, DNN, DPP, DND, DPD, DPN, DNP. That was his first list of nine. He said that he repeated that same pattern for the two other columns but started with pennies and nickels instead of dimes.

Jenny objected, stating that she followed a pattern too, but didn't see what José had that she didn't. Jenny walked to the board to compare the two solutions.

As the students shared solutions, they challenged each other's thinking and reflected on their own thinking processes. They thus created a metacognitive awareness of their solutions, which helped them monitor their own problem-solving behaviors (Schoenfeld, 1992) and deepen their learning.

3. Children learn when their learning is embedded in themselves, their homes, and their communities.

By assisting students to seek pathways of discovery for their curiosities, we are equipping them to bridge their school mathematics learning to their lives outside school. Helping students to look at their neighborhoods to ask questions about what they see and know provides a social life for knowledge and meaning-making as an ongoing, collaborative process.

In November 2002, 42 students, parents, and younger siblings attended an all-day retreat one Saturday at New York University. The theme of the day was "Geometry All Around Us." Parents and students worked in groups to build the tallest tower possible using only straws and masking tape. We then discussed how the groups worked together and what construction challenges they encountered. Several groups raised questions about why triangular structures seemed to be the strongest. A walk around the community in search of architectural designs and characteristics elicited further questions and theories about geometric construction. The real-life examples provided an opportunity for the students and their families to think critically not only about the straw structures they had built but also about the geometry inherent in the world around them.

Research Field Log (11/2/2002)

Judy: What did you notice on your walk?

Jenny's mom: All the scaffolding had diagonal bars just like the structure we built. I think it's about creating triangles.

Kenny: But buildings are rectangles.

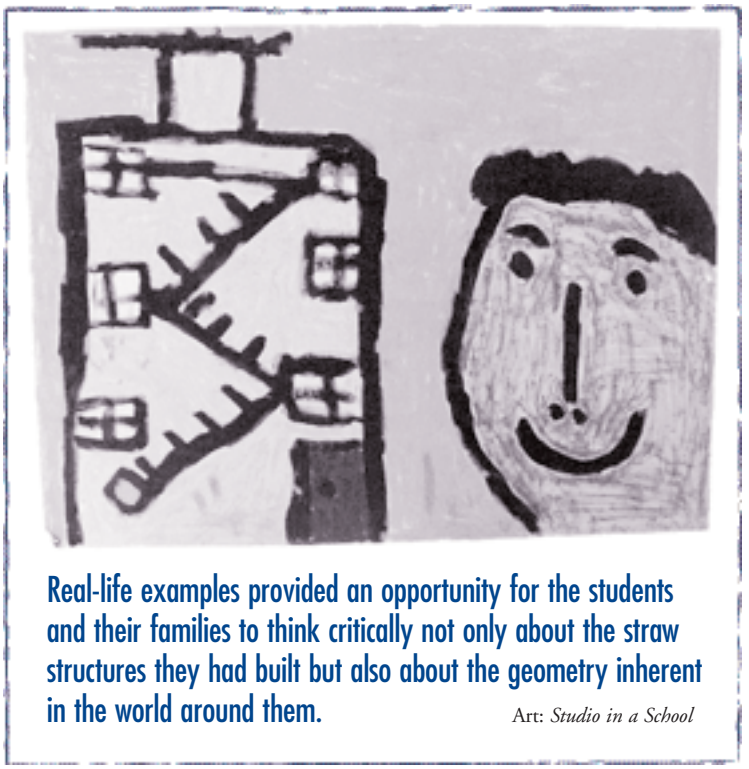
Kayla's mom: It's like I tell my daughter, it's the foundation that matters the most—what holds it up. It might be that the base of buildings have more triangles in them than what we can see above ground.

Rosa's dad: That's interesting because we saw the construction over on the other side of the park and all the

walls above ground also had diagonal supports. So those supports are in between the walls, which we can't see.

Kenny's brother: I don't think it's necessarily the triangles, but it just has to do with angles. Like the fire escapes are all angular so they have a zigzag-type shape to them.

This vignette illustrates Milbrey McLaughlin's (2000) notion of learning from community involvement. McLaughlin posits that knowledge is socially constructed and involves higher-order concepts created in the lives and heads of those who want to know. This kind of knowledge carries over into a lifelong sense of empowerment and confidence in dealing with the complexities of life.



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Pitfalls

Reflecting on our Afterschool Principles in practice after one year of operation, we find that our vision encountered unexpected pitfalls. The following real-world factors created temporary challenges to implementation:

- The pervasiveness of high-stakes testing
- School homework policy
- Children's need for correct answers

Although these pitfalls can be overcome, they caused concern, and, in some cases, required us to adapt the In Addition program.

Testing Is Pervasive

We intentionally designed In Addition to help children learn in a test-free context. We created a community of learning that allowed students to ask questions, follow their individual interests, and seek their own solutions. What we did not expect was the way testing hovered over our community. The forces in education and city politics that emphasize accountability in the form of "passing the test" made it impossible to escape the power of testing over the learning process. Early in September—after we had articulated our "No Test Prep" mantra several times to the school's principal and assistant principal and gained their agreement—the assistant principal handed us the fourth-grade test preparation booklet and suggested that we design afterschool lessons to "cover" those skills. We chuckled and put the booklets away someplace, still unaware that they signaled that more testing mania would follow.

In March, In Addition students began announcing that they would not be able to attend the project every day because they had to get tutoring for the upcoming tests. The school had set up test preparation sessions after school, assigning students to particular days, times, and subjects for their tutoring—and sending a powerful message about what learning is and what counts. One parent even told us her child would not be returning until April because the child needed *math* tutoring.

One way we began to counter the message that only the test matters was to incorporate testing discussions in our bimonthly parent workshops. We talked about how to reduce the stress of testing, offered test-taking strategies, and raised awareness of the impact of high-stakes testing. As we move into our second year, we continue to work to ameliorate the test syndrome without destroying children's and parents' faith in their school.

Homework Dominates

We did not include homework help in our project design, nor did we assign homework. From the very first day, In Addition students wanted to know why

they couldn't do their homework. We were not surprised to find that the children's math homework consisted of computational, one-answer, short-response workbook problems. Spelling homework often involved writing words three times each and putting the words into sentences. Reading and social studies homework consisted of comprehension questions.

One day our daily graphing question asked, "How much time do you spend doing homework a night?" A majority of students answered that they spent an hour to an hour and a half on homework each night. The following excerpt illustrates the pressure they felt.

Research Field Log 11/20/2002

Kim: Our teacher gives us eight homework assignments a night!

Jenny: Yeah! Sometimes she gives us time to do it in school, but I still have a lot when I go home.

Rosa: And my father only gives me a little time to do my homework when I get home because I have to be in bed at eight.

José: And sometimes it's just so much, but I don't even want to know what my mom would do if I didn't get my homework done. She just tells me I have to do it.

Two students dropped out of In Addition because the pressure of homework was too great. The reality was that students left the program at 5 PM facing an hour or two of homework before bedtime. By November, we decided that we had to respect the students' and parents' need to have some homework completed after school so the evening at home would be less stressful. After discussion with the children, we came to a compromise that extended the afterschool program for thirty minutes to allow time for homework. We spoke with the principal and assistant principal about the homework issue and explained our solution.

However, we stated clearly that this compromise was a short-term answer. Our ultimate goal is to engage teachers and administrators in discussions about how much homework and what kind of homework is necessary. We spoke with the assistant principal about setting a meeting to discuss the possibility of changing the school's homework policy for the following year. His response was neutral, and our plan is to pursue this goal later in the year. At this juncture, our strategy is working: The children seem less harried and afterschool attendance is not suffering.

Children's Lives Are about Answers

Children are naturally curious about their environment. The role of the adults in their lives is to nurture this curiosity and wonder. In our afterschool program, we want to guide children to form questions, make decisions, and come to conclusions about the world around them. As Steven Levy (1996) points out:

> Questions are at the heart of thinking. We carry on an internal dialogue that forms thoughts and then questions them. Many children do not yet engage in this inner dialogue. They need someone else to play the role of questioner. One of our goals must be to help the students develop the habit of inner dialogue, asking questions of themselves to explore and develop their own thinking. (p. 36)

However, we are discovering that children's academic lives are more about answers than about questions, more about "getting it" than about wondering, and more about what someone else believes they need to know than about letting their curiosity compel them. Nowhere in the lives of our students is the focus on their own questions. The following conversation between the In Addition students and Tricia, the NYU graduate student, shows how the students view their own learning, offering a glimpse into their classroom experience.

Research Field Log (11/6/2002)

Tricia (NYU graduate student): What I am most concerned about, when we are solving a problem like this as a class, is not who is right and who is wrong. I am interested in looking at the solutions so we can understand the thinking involved in getting any solution. The point is to learn from one another, not to be competitive.

Miguel: Not gonna happen, Tricia. We are competitive 'cause a lot of us are in the same class and we want to be right. Our teacher tells us that, if we don't get the right answer, she lowers our grades and the same kids always get a lot right.

Tricia: Can someone have an important idea without having the right answer?

Natalie: Like when I was in José's group, I thought that I was better than him because he's not in the advanced class, but then I realized that he had good ideas too.

In our afterschool program, we work to change the attitudes of children who, like Miguel, have internal-

ized the message that getting the right answer is more important than are wanting to know or gaining deeper understanding. We are always discussing the types of learning that are valued by others in the children's lives in hopes of expanding their thinking.

Coping with the Challenges

The In Addition story continues to unfold and to have its impact on its leaders, the students, their parents, and their classroom teachers. Rome wasn't built in a day, and school change doesn't happen as rapidly as we would like. As John Dewey (1916) notes, "Growing is not something which is completed in odd moments; it is a continuous leading into the future" (p. 65). In our second year, we continue to grapple with the challenges that the school environment imposes on our afterschool program. Our strategy depends on keeping our vision intact and sticking to practices that promote our Afterschool Learning Principles.

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About the Authors

Dr. Judith McVarish is an assistant professor of mathematics education in the Steinhardt School of Education, Department of Teaching and Learning, at New York University. She has worked in mathematics education for over three decades as a teacher, tutor, staff developer, and professor. Her research interests include how teachers and students develop and assess their mathematics understanding and how the afterschool setting can be used to increase elementary students' mathematics engagement and learning. She has also studied urban teachers' beliefs about obstacles to effective mathematics teaching.

Patricia Birkmeier has a master's degree in elementary mathematics education from New York University and is currently a fifth-grade teacher in the New York City public school system. She previously taught fifth- and seventh-grade mathematics in Massachusetts. She has served as project coordinator for the In Addition Initiative for two years. Her research interests include teaching for mathematics understanding through exploration and problem posing