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Turning the Tide: A Thoughtful and Developmentally Appropriate Approach to Teaching Mathematics

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Contemporary Contexts

At our school, we recognize that providing high quality education in mathematics so that our students are equipped for their futures is no easy feat. With this in mind, and in line with our mission, we try to embrace an attitude of constant self-reflection with the intention of improving our work. Our approach to learning and to planning our work is driven by research. We strive to foster not only competent mathematicians, but also students who get pleasure from engaging with numbers and who understand the significance of math. In order to reach this goal, one aspect of our work is to undo the influence of "math phobia," a phenomenon so prevalent in our society in which math is often viewed as unappealing, mysterious, and inaccessible. If you combine the possibility of children's preconceived ideas gained from this cultural norm with the fear of making mistakes, and a modern world filled with expectations for instant gratification, the necessity of building the groundwork becomes clearer. We need to create safe environments where children feel comfortable taking risks, persevering through challenges, and believing in their capacity to do math.

The Bank Street credo and our practice emphasize courage, engagement, and flexibility; our school values empowering students, respecting individuals, viewing mistakes as learning opportunities, and developing self-efficacy. A key objective we share with the National Council of Teachers of Mathematics is for children to have the expectation that their math work make sense to them, and then to actually have it make sense. Those two things engender a sense of confidence as well as real competence.

Math Misunderstood

The unfortunate reputation the subject has often gained is largely due to the way many of us learned math ourselves: by memorizing facts and procedures, applying them, and then moving on, we were placed in the role of passive receivers of information. Within such a framework, math became a mechanical rather than a creative process: we relied heavily on memory, conformity, and compliance, while underlying concepts often remained unclear.

We have had greater aspirations for our students, however. Lucy Sprague Mitchell, Bank Street's founder, wrote in our credo that we want to develop "a zest for living that comes from taking in the world with all five senses alert," and, "lively curiosities that turn the world into an exciting laboratory." We want our students to experience what mathematicians do and to actively engage with mathematics by searching for patterns, making conjectures, proving or disproving theories, solving problems, and sharing work and discoveries with their peers. We want to nurture critical thinkers and problem solvers; we want children to learn by doing and through exploration. We understand this places higher cognitive demands on students, yet know this is what is required for optimum outcomes. When the practices of mathematicians are incorporated in a curriculum and school philosophy, and a secure understanding of mathematical content is fostered, the odds are high for igniting passion for the subject, in addition to developing proficient and confident mathematicians.

Sally Borduin (right) teaching math

It is not the knowledge of and ability to carry out a standard algorithm that determines a strong student in mathematics. It is far less taxing to memorize a procedure and carry it out without much thought, than to manipulate numbers in personally meaningful and efficient ways based on deep understanding of the number system. Historically, much math education has focused on such low level cognitive demands and has produced many people who remain afraid of math. We want our students to learn more sophisticated and flexible ways of calculating, based on their understandings of how numbers can be put together and taken apart. Emphasis on the underpinnings of addition, subtraction, and the base-ten number system in the first half of Middle School supports this endeavor, and students come to learn standard algorithms later in Middle School to add to their repertoire.

Our Program and Approach

Throughout the Middle School, teachers predominantly use *Investigations in Number, Data and Space* (TERC, 2012), alongside knowledge of their students, to plan learning experiences for their students. It is a child-centered, developmentally-

appropriate, research-based program, in which children are guided to be meaning makers, build on what they know, approach mathematical tasks in their own ways, make connections, think flexibly, discover relationships, and understand that there are multiple strategies for solving problems. By investigating how many red and blue crayons there may be in a set of 10 such crayons, a student in the 6/7s experiences that math tasks can have more than one correct answer. They are also challenged to find *all* the possibilities, then see if they can discover and use a mathematical structure, and generalize it to other similar problems, making logical estimations before doing so. Classroom discussions elicit communication of a variety of strategies, so students are exposed to multiple representations and can deepen their understanding of available pathways to solutions. Teacher recordings of varied student methods aid developing understanding of standard notation to write equations, important for algebra.

Students in the 6/7s and 7/8s at the School for Children can frequently be found playing many math games with their classmates. Engaging in these games is one way our curriculum addresses the 5 Strands of Mathematical Proficiency as outlined by the *National Research Council: Conceptual Understanding, Procedural Fluency, Strategic Competence, Adaptive Reasoning, and Productive Disposition*. The games are also designed to facilitate conjecture and discovery, which encompass foundations of algebraic thinking (such as a + b = b + a). Teachers guide small and large group discussions around these important mathematical ideas, facilitating effective communication, representation, reasoning, and proof. Math is not solely taught through games or purely during discrete math periods. For example, learning about data and measurement takes place during social studies too. Most investigations are grounded in real-world contexts, such as when the 7/8s analyze line plots and uncover the story the data has to tell about classes of students and the teeth they have lost.

Students experience a wide variety of tasks and problems built on a visual and hands-on approach to learning about number operations, algebraic thinking, measurement, data, and geometry. They use many concrete tools, which ground and deepen their understanding and support building a bridge between the tangible and abstract. In addition to helping students reason and make discoveries about quantity, shape, and space, hands-on materials also help students share and model their ideas and agree or disagree with mathematical arguments. Math tools are introduced in thoughtful and meaningful ways; the 6/7s classes construct a 100s chart from a number line before using the tool to ensure greater understanding of its configuration and purpose. Visualization is important in math, as the development of mental images supports mathematical understanding. Students are shown Quick Images of quantities and shapes to build such mental images and consider and discuss attributes of numbers and shapes.

Confirmation of Our Goals and Vision

High school admissions officers have commented that our students are engaged, cooperative learners and critical consumers of information; ask good questions; and perhaps most notably, know how to think. Lucy Sprague Mitchell wrote as a goal in our credo that we want for human beings to develop, "…the courage to work, unafraid and efficiently, in a world of new needs, new problems, and new ideas." With the future uncertain by nature, we feel optimistic that we are developing a courageous group of mathematicians who expect to make sense of their ever-changing world, and have had a solid foundation in learning how to learn.

References

Bank Street School for Children. (2014). (n.d.). *Misson & credo*. Retrieved from http://bankstreet.edu/school-children/about-sfc/mission/

Burns, M. (1998). *Math: facing an American phobia*. Sausalito, CA: Math Solutions Publications.

Hiebert, J. C., Carpenter, T. P., Fennema, E., Fuson, K. C., Human, P. G., Murray, H. G., Oliver, A. I., & Wearne, D. (1997). *Making Sense: Teaching and learning mathematics with understanding*. Portsmouth, NH: Heinemann.

Kilpatrick, J., Swafford, J., Findell, B., & National Research Council (U.S.). (2001). *Adding it up: Helping children learn mathematics*. Washington, DC: National Academy Press.

National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics*. Reston, VA: Author.

Stein, M. K., Smith, M. S., Henningsen, M. A., & Silver, E. A. (2009). *Implementing standards-based mathematics instruction: A casebook for professional development*. New York: Teachers College Press.

TERC. (2012). *Investigations in number, data and space* (2nd ed.). Glenview, Ill.: Pearson Scott Foresman.