Interactions with School Mathematics

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Reading Jo Boaler’s book, Experiencing School Mathematics (2002), has been career changing, if not life changing. I have read myself into her words, her teachers’ words, and her students’ words again and again. At times, these words have unsettled me and made me very uncomfortable. At other times, they have freed me from my past, motivated me in my present, and inspired my future. Her book has made me think, reflect, and question how I have interacted with mathematics as a student, as a teacher, and as a lifelong learner.

As a Student

I never genuinely understood math as a student. I was a very successful math student, however; at the top of my class, achieving honours almost every year. I was very good at watching teachers demonstrate their work on the blackboard; I could copy the steps and practice the questions in the textbook. I memorized rules and procedures and performed on tests. My approach worked from elementary school, through junior high, and into my grade 10 Advanced Placement class. Then the mathematics got too difficult. I did not fully understand the steps; I could not entirely follow the lessons. I had trouble keeping up; I was the last student to finish every assignment and every test. I asked questions, I stayed in at lunch, and I went for extra help. I tried to work with my friends in class, but they were too fast and wanted to rush through the assignments. I had a good relationship with my high school math teacher. He taught me math in grades 10, 11, and 12, and he was my cross-country running coach. He was strong mathematically, and he wanted me to succeed. So, he showed me repeatedly how to do the questions. Every time, he pushed a little bit harder on his pencil and spoke a little bit louder, becoming agitated at my lack of comprehension. I would ask “why”? I would ask “how”? His response would be to show me once more how to get the answer. I struggled through three years of high school math, never really thinking for myself or understanding, just reproducing my teacher’s work and his answers. My confidence in my mathematical abilities took a nosedive; I stopped asking questions and I stopped trying to understand. As a result, I fell further behind, dropped out of Math 30AP, and started over in Math 30. I was embarrassed; I felt like a failure. I started Math 30, nervous, uncertain, scared to take risks, and definitely not up for any challenges. The second time around was easier – I rememorized formulas and procedures, and followed my new teacher’s methods on the blackboard. I played the new game, this time without calculus and was back on the honour roll in time for graduation, vowing to stay as far away from mathematics as possible.

After reading Boaler’s book and reflecting on my experiences as a student, many things that have become clearer to me. For most of my life as a math student, I was, what Boaler would call, “effective” in the classroom (Boaler, 2002, p. 130). Just like her Amber Hill students, I could adhere strictly to the rules (in school and in mathematics), I could interpret non-mathematical cues, and I could suppress my thoughts. Being effective in the mathematics classroom allowed me to attain high marks and to be successful for a long time. By high school; however, it became more difficult, as I had problems understanding mathematical concepts and I could not continue to fake it by following the steps. My “quest for understanding” did not allow me to continue to play the “school mathematics game” (Boaler, 2002, p. 139); therefore, I struggled to learn, to understand, and to succeed. Jo Boaler speaks to my heart when she talks about her underachieving top set girls: “These girls, more than others, wanted to understand their mathematics. Consequently, these girls, more than others, became anxious and underachieved when they were denied the opportunity to do so” (Boaler, 2002, p. 152-153).

Boaler continues to describe me as a learner when she affirms “Women tend to value connected knowing, characterized by intuition, creativity, and experience, whereas men tend to value separate knowing, characterized by logic, rigor, and rationality” (Boaler, 2002, p. 138). Furthermore, she claims “Girls also prefer cooperative, supportive working environments, whereas boys work well in competitive, pressurized environments” (Boaler, 2002, p. 138). The first parts of both of these citations describe me as a learner, whereas the second parts describe the learning environment of my high school math class. Boaler’s research with her Amber Hill students indicates that the learning environment in the most advanced school math classes had diminished students’ mathematical understanding (Boaler, 2002, p. 163). Moreover, she reports that some of the top set students stated comments similar to those below, suggesting why the students were not learning, resonating deeply with me and bringing back negative feelings about my experiences learning mathematics:

“The teacher rushes through methods faster than most pupils can cope. The lesson is difficult, and we work at such a fast pace that I find it hard to keep up. I dislike basically everything. The methods of teaching are too fast and confusing” (Boaler, 2002, p. 161).

I wish I had read Boaler’s book and gained this insight as a high school math student. I wish I would have understood myself as a learner and how my math classroom was not an effective learning environment for me. I would not have experienced as much frustration and anxiety; I would have perhaps realized that the problem was not that I could not understand, the problem was that my teachers could not help me learn. I wonder how much I could have learned if I would have been given the opportunity to be in an atmosphere similar to Jim’s math class at Phoenix Park School: open and reflective, full of discussion, cooperation, different strategies, and multiple answers. I would have liked to learn mathematics in a classroom where thought was encouraged and where understanding was the goal (Boaler, 2002).

As a Teacher

Four years and a Physical Education Degree later, I took a year to find myself by taking a variety of courses and playing college hockey. During this year, I withdrew from an accounting course because the numbers and procedures scared me and I did not want to fail. Then, I went back for my Education After-Degree. I found myself in a ‘How to Teach Math’ class, and it was here that I started (or continued) my journey toward becoming a math teacher. We spent the semester learning math. I was a student again; facing my insecurities, challenging my beliefs, and genuinely understanding mathematics for, what I felt, was the first time. We spent most of our time doing, learning, and constructing our own knowledge. Then we spent time on the front matter of the curriculum. It was in this classroom with this teacher where I realized that I could maybe help students understand math.

As an excited student teacher, armed with open-ended activities, real-life problems, and dreams of changing the world, I quickly realized that change does not happen quickly, and it is quite difficult to enact. I survived my practicum with direct teaching, textbooks, worksheets, and word problems. I was teaching the way my practicum supervisor taught, and the way I was taught. I was teaching students to believe that “all of maths is just sums, rules and equations and none of it makes sense” (Boaler, 2002, p. 32), similar to what students at Amber Hill believed as they watched their teachers do math on the board, similar to what I believed as a student.

As math teachers, we understand what we are teaching and what we are discussing with our students. Our students; however, do not have our same background, experience, or learning style. “Teachers are driven by a desire to compartmentalize and provide models and structures that make sense for teachers but often do not for students” (Holt, 1967, as cited in Boaler, 2002, p. 32). This is probably why, as a beginning teacher, my understanding of mathematics became broader and deeper every year. I was teaching myself as I was trying to impart my knowledge to my students. I was constructing my own understanding, creating my own models, and then demonstrating what I was learning to my students.

I was strongly influenced by Boaler’s observation that because teachers wanted to move quickly through work, “they did not waste time on students who could not provide correct answers” when they questioned students from the front of the classroom (Boaler, 2002, p. 33). I have often done this as a teacher, either in showing a procedure, discussing answers, or reviewing a concept. I have asked questions and continued as soon as I heard a correct answer. Often this answer was from one or two students, and I would take this as proof that I had covered a topic or successfully taught a concept. These students probably could have taught themselves the whole curriculum; the fact that they could come up with a correct answer quickly did not prove that learning was happening in my classroom. The other 95% of the students in the class were still either thinking about the concept, trying to understand the math, calculating an answer, or shutting down because it was all moving too fast. As a teacher, I have been pushing the curriculum down their throats as fast as I can. I have been trying to do it quickly to make extra time to review for the final examination at the end of the year. I have been trying to make time for problem- solving blocs and inquiry-based learning approaches so I can believe that I touched on the front matter: the important skills like reasoning, communication, and mental math. In reality, I have been teaching students to memorize formulas, copy my strategies, and get the right answers as quickly as possible. I have been teaching them my knowledge and explaining to them my understanding, instead of teaching them to think, teaching them to learn, and teaching them to be problem solvers.

I believe in the constructivist approach, teaching with open-ended problems, and developing students’ personal strategies. This is what I would work on after covering the curriculum or apart from the curriculum, instead of as the curriculum and as all- encapsulating teaching activities. I was still following the textbook and teaching all of the strategies. Many of my strong students were bored and did not understand why we had to learn so many different strategies, whereas my weaker students were confused and frustrated, not deeply understanding any of them. This would result in a general state of confusion and I would backtrack, re-teaching the strategy I was most comfortable with and re-explaining how I understood the concept. I was not creating creative or engaged students nor was I developing effective or confident learners. My students were interacting with me and with the textbook; they were not interacting with each other or with mathematics. Boaler refers to this issue in relation to the teachers she observed at Amber Hill School. These teachers stated that it was important for the students to find their own ways to solve problems, but in the realities of everyday life in the classroom, this rarely happened because they would not let it (Boaler, 2002, p. 28). I was so busy teaching the outcomes that I was not even letting my students solve real problems, so it was next to impossible for them to develop their own problem- solving strategies, let alone life skills in numeracy.

My primary goal as a teacher has been to teach the curriculum by covering all of the outcomes and preparing the students for the final examination. Boaler speaks often in her book about the speed and pressure in the mathematics classroom. Teachers believe that they do not have enough time to cover the curriculum; therefore, they keep students working through exercises quickly. Students learn, as a result that mathematics is all about speed, all about quickly getting the right answers. The worst feeling as a teacher is standing in front of the class, on a time crunch, trying to teach every outcome at the whiteboard. I have done this to some extent every year, usually during the month of June. I believed that if I could cover every outcome, touch on each concept, show them how to do every examination question, I had done my job. Boaler’s work has reminded me that my job is not to teach every outcome in the curriculum but to help my students learn mathematics. She has reminded me that the most important part of the curriculum is the front matter. I need to help my students learn to reason, to solve problems, to work in groups, to communicate, to make connections, to use mental math and estimation, to take risks, and to persevere.

Boaler’s observations and research confirm in my mind the dangers of traditional teaching methods. She found that the traditionally- taught students from Amber Hill would use cues from the textbook, the classroom, or the teacher to decide which mathematical procedures to use, instead of choosing based on the mathematics required. They could perform the procedures, but only if they knew which one to use. They thought that they had to memorize the mathematics, learn the rules, and spot the clues in the questions, rather than think about the questions and approach them appropriately (Boaler, 2002, p. 108-109). Furthermore, she observed that students were successful on tests but could not use their knowledge in applied activities. The students had difficulty remembering the rules and procedures that they had learned previously and they could not successfully apply these rules and procedures to problem- solving situations (Boaler, 2002, p. 111). Finally, the students …“believed the mathematics they encountered in school and the mathematics they met in the real world to be completely and inherently different” (Boaler, 2002, p. 111), that the math they learned in school was not related to the math they needed in their jobs or in real life (Boaler, 2002, p. 123).

I do not want this for my students or for my children. I do not want them to memorize rules and procedures; I want them to learn to think and to use mathematics in the real world. Boaler reminds me … “neither professional mathematicians nor professional users of mathematics spend their time reproducing standard procedures” (Boaler, 2002, p. 133). We have calculators and computer programs; we no longer need humans to do long division; we need them to use mathematics to create, invent, improve, trouble-shoot, and solve problems. We no longer need humans to crunch numbers; we need humans to use mathematics to make our world a better place. “Put simply, if we want students to consider mathematical situations and flexibly make use of mathematics knowledge in the real world or in examinations of higher mathematics, we need to engage students in similar practices in the classroom” (Boaler, 2002, p.179).

As a Lifelong Learner

My classroom looks and feels different this year than it has in the past. Students are working together on rich tasks and problem- solving activities to learn mathematics. My role has changed from teacher to facilitator. The students no longer watch me do math; they engage with the numbers and the problems, they engage with each other, and they engage with me. The textbook is no longer a teacher but an extra practice tool. My students are rarely late for class. They may not bring their math binders or even their shoes, but they are on time and ready to work. I am also seeing a big difference in my students as learners. They less often say things similar to “I don’t understand” or “What do I do”? They know not to ask me for the right answers. I hear more comments similar to “let me show you what we did”, “we got it”, and “I am good at math!” My classroom is becoming a “thinking classroom.” It is loud, energetic, and full of learning.

My two Math Seven classes just learned how to add and subtract integers. I did not spend any time in front of the class at the whiteboard; I did not show them any strategies; I barely told them what to do. My students taught themselves and each other how to manipulate positive and negative numbers. Some students used poker chips, some students used number lines, and others invented their own strategies, some of which I have never seen. Many of the students used their mathematical intuition. Imagine, students getting the freedom to use their gut instinct and not needing to do math the teacher’s way or use a method given in the textbook. Figuring out how to let the students learn has been the strongest lesson and the most powerful change in my classroom. As evidence to the effectiveness of not teaching, every one of my 41 students passed their unit exams. Not just my open ended, “*explain all you know about adding and subtracting integers and prove it with examples”* exam but also a traditional “*give me the answers”* exam that I have given every year. Every student! No extra help at lunch, no extra help after school, not one minute of direct teaching at the board. Even more shocking to me was that the students only needed three weeks instead of the usual four, and I was sick for four days of this time. Better success rate, no teaching at the whiteboard, and partly with a sub? All I gave them were four equations on the board, a practice test with the answers, some investigation activities, and IPADs with integer games. They worked in random groups, using number lines, poker chips, IPADS, markers on whiteboards, their brains, and the brains of their peers. They also used their communication and reasoning skills. They discussed with their peers and make connections with the math. Not only did my students learn to add and subtract integers, but they also started to learn that they could be successful and confident with mathematics.

Boaler emphasizes the importance of using open- ended activities in the math classroom: “Phoenix Park students reported that they developed motivation and self-discipline as a result of the school’s approach, that the openness of their work encouraged them to think for themselves, and the need to use mathematics in different activities caused them to be adaptable and flexible in their approach to mathematics” (Boaler, 2002, p. 183). If I could help my students learn to think for themselves, confidently approach problems, adapt to different situations, and use their mathematical abilities in a flexible way, I would be doing my job as a math teacher. Boaler speaks of how the findings of her research show that math lessons in schools would be improved if students experienced excitement and engagement. She states that the essential part of this improvement is designing appropriate activities and creating a stimulating classroom environment (Boaler, 2002, p. 184). I have spent the last three months working with my students to create a stimulating environment – our “thinking classroom.” I will continue to focus on finding and designing the appropriate activities to engage my students, and focus on the important mathematical skills students need to be confident and successful learners of mathematics.

Boaler’s research describes how the teachers who allowed the most learning to happen in their classrooms required their students to think; they provided minimal guidance and structure (Boaler, 2002, p. 128). These effective teachers gave their students choice in their work, their mathematical approach, their organization methods, their behaviour, and their work environment (Boaler, 2002, p. 67). More importantly to me, …“the teachers were extremely skilful in the ways in which they navigated students around the mathematical terrain” (Boaler, 2002, p. 83). Boaler expresses how important it is for teachers to ask students to explain what they know, to listen carefully, and to then choose appropriate interventions. I need to improve how I navigate my students in my teaching practice. I need to learn how to hold back, how to explain less, how to be more patient. I need to learn how to intervene effectively, how to pose thinking questions, and how to motivate students in their learning. I want to help my students genuinely understanding mathematics by letting them learn.

Starting with my “How to Teach Math” class in university, continuing throughout my first five years as a teacher, and during my year as an AISI (Alberta Initiative for Student Improvement) math coach, I have known what a math class should look like. I know what kinds of activities students are supposed to engage in; I know what kind of learning is supposed to take place. I realize that the focus is supposed to be on the front matter; I understand the seven mathematical processes wherein this learning is supposed to occur. What I have not known is how to make it happen, how to start, how to not direct teach, how to allow the students to learn. As a lifelong learner and educator, I am finally taking another important step in my journey. I am learning HOW to get there, one step at a time. Jo Boaler’s book has reiterated the importance of what we are doing in our Numeracy Cohort and has motivated me to continue making change in my classroom. Boaler’s research and experiences described in her book support what we are learning in our Master’s classes and supports what we are doing in our classrooms. After reading Experiencing School Mathematics, and reflecting upon Boaler’s words, I can see that my experiences as a student, as a teacher, and as a lifelong learner have led me to where I am today. I strive to do what my teachers could not do for me; I strive to help my students develop a deeper understanding of mathematics. I want them to be confident in their abilities; I want them to use their math skills in real life; I want them to see the beauty of numbers and patterns, and enjoy their own journey toward understanding mathematics.

References

Boaler, J. (2002). *Experiencing school mathematics*. New York, NY: Lawrence Erlbaum Associates, Inc.