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Some Notes on How Students Perceive Mathematics

Joan Countryman
The Lincoln School

Constance Reid's charming biography of E.T. Bell[1] has a chapter entitled, "The Human Side of Mathematics." She begins with the sentence, "It has been said, possibly by Bell himself, that the human side of mathematics is mathematicians." One thing I have learned in years of work with high school math students is that few students see anything human (or humane) about mathematics. This may be due, at least in part, to the fact that they do not see any mathematicians in mathematics. What they do see, and I quote here from an essay by Alfinio Flores, "The Shadows of Mathematics," published in the *Arithmetic Teacher* of April, 1993, "is rote learning, meaningless procedures, unrelated topics, and memorizing formulas. For them, learning mathematics is developing skills in symbolic manipulation of numbers and formulas, little understanding, and no fun."

Ruth Parker, in *Mathematical Power* [2], a lively discussion of teaching math in elementary classrooms, reminds us of the contrasts between the mathematics that is done in school and the mathematics that mathematicians do. (See Table 1)

Twenty five million children study mathematics in school in the United States; most of their time is devoted to computation, practicing tasks that hand calculators can do faster and more efficiently. If you ask those children to tell you what it means to do mathematics they will tell you add, subtract, multiply, divide." Unfortunately, as they get older, many of those children will say that they hate mathematics.

You will hear this in the words of my students, as they describe their experience of mathematics. Here is the voice of K..., a student in an honors course:

> My earliest math memory is associated with failure. [In a new school] I didn't know how to multiply and the rest of the class was doing multiplication problems. I struggled to memorize the multiplication tables but I could not understand the concept of multiplication ... The next math memory that seems relevant is one during my seventh grade year. We began to learn algebraic equations and I couldn't understand what the "x" meant in an equation like $5x + 3 = 18$. The concept of what "x" stood for escaped me. I felt useless and stupid when I couldn't even imagine how to solve or what to solve for in these equations.

Table 1

School Math	Real Math
Neat and concise	Messy
Speed, getting answers quickly	Persistence and flexibility
Right answers	No answer book
Arithmetic and manipulation of symbols	Diverse domains, including geometry, patterns,functions, logic, data analysis, etc
Calculators after basic skills	Tools available to examine and represent ideas
Math done alone	Math used to make sense of information; collaborative work[3]

K... had become a student who wanted the teacher to "just tell me how to do it;" but C... was more confident about his own ability:

> In elementary school I was a very good math student and always found myself working on math level tests much higher than those of my classmates. My teachers pushed me very hard, and I often got private lessons with the teacher while the rest of the class was working on other problems. I remember being proud of being the only third grader in the school to know long division.

Nevertheless even C... saw long division as central; it represented a mathematics that was complicated and difficult.

These themes arise frequently in the comments students make about themselves as learners. Here is a calculus student, Molly, who was skeptical about her ability to do mathematics, an activity which she equated with getting many right answers.

> "I think that I am not a mathematical person. I enjoyed the class, but I really don't think I learned anything except how to flunk with dignity . . . I think that this is a hard course. I tried but my best just didn't make it. I am glad that I stuck with it, though. I really don't care for integrals, limits, etc."

Hilary, a student with a more positive image of herself as a learner, said, "Math is fun when you get it right. Otherwise it's frustrating."

> "I think that some math is fun. So far I like algebra. I never learned how to do math really well, but what I do learn I remember, or at least I try to remember. When I was in sixth grade I learned the most math."

> "I'm not bad at math once I get the hang of what I'm doing, but I usually rush and make dumb mistakes. Math to me should be just +, -, x, ÷.

Although my intention here is to describe, and not to prescribe, I do want to suggest a direction that might help disabuse students of the notion that math is arithmetic and arithmetic is only boring and/or difficult. In a high school course[4] that was rich and thick, *mathematical,* if you will, I found students commenting in their journals about a discipline that seemed much closer to the math that real human beings do.

> I still really love the whole idea of closed and recursive equations. It seems that if you can talk about the way a function's input and output are related in such a general way, then you really know a lot about the numbers you're dealing with. The relationships between the numbers transcend what the values of the numbers may be.

Listen to the voice of a high school mathematician, a student in the same course, describing his work in this longer entry:

> It seemed to me when I was reading the section about building an irrigation system that the whole problem was misdirected. After several pages of calculations and explanations, I thought that the problem of even water distribution could have been easily solved by substituting a long "flat" water spout (sort of like the ones in fancy bathtubs) in place of several round ones. Of course I may not have thought of an alternative system except for the complexity of the calculations, which means that the lengthy explanation was good because it got me to think: "Isn't there a simpler way?" This is sort of like the tape recorder problem where after several pages of calculations and formulas the authors declare that something is wrong and that we need to do the problem all over again. I think that this brings us to a fundamental question we need to consider in the construction of mathematical models: is our answer the solution to our problem? Often, in the course of adding, subtracting, and otherwise mathemetizing, we lose sight of the ultimate goal, and if we answer the wrong question, or if our answer is complicated, then what good is that answer?

When the mathematics that we teach is real our students will perceive its humanity. I share with Ted Sizer, whose Coalition of Essential Schools is currently receiving national attention, the conviction that in high school we need to give all students practice in thinking hard about problems that matter. What if the goal for every math course were that at the end of the course students would want to take another? It is a challenging vision.

Notes:

[1] Constance Reid, *The Search for E.T.* Bell.Washington, DC: MAA, 1993

[2] Ruth Parker, *Mathematical Power*. Portsmouth, NH: Heinemann Books, 1993

[3] from *Mathematical Power*.

[4] Contemporary Precalculus with Applications. North Carolina School for Science and Mathematics,. Janson, publisher.

Poetry by Monte J. Zerger

Adams State College
Alamosa, CO

Mistress of mine, time and
Again you have wooed me with your
Theorems and proofs,
Held me captive with your abstract beauty, and
Enchanted me with your dance.
Mistress of mine, time and again I have been
Awed by the
Transcendent melodies you weave and the
Infinite tapestries you spin from only a sparse
Collection of symbols and
Signs. Mistress of mine, it has been a long and glorious romance.

Match Mates

All day in this game I equate
So I find it perfectly great
    that anagrammatics
    transforms "mathematics"
Into these three words, "I match mates"