Who Needs Mathematics Teachers?

David Wagner

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Considering the wealth of available resources in today's mathematics classroom we might wonder if teachers are necessary. And if we teachers are necessary, what roles do we need to fill? This review of portions of the two textbooks authorized for Alberta's Pure Mathematics 20 course, Mathpower 11 (Knill et al., 1999) and Addison-Wesley Mathematics 11 (Alexander & Kelly, 1998), forms the setting for my questions about the role of the mathematics teacher.

I looked specifically at the two books' treatment of graphing calculator technology within the quadratic functions topic. The analysis that follows considers the special graphing calculator sections in these books, and the questions and examples that explicitly suggest graphing technology, either verbally or with icons.

Comparing Two Textbooks

Love & Pimm (1996) assert that books cannot avoid creating a model world (pp. 390-392). Textbook authors' choices of images, language, and structure are best suited for a certain type of reader, and these choices influence their readers to become more like this "model reader". The constructed reader in the case of the textbooks under consideration is clearly the mathematics student, but for a better understanding of the influence of these books, we might consider the kind of student who is implied.

One way of examining the model student constructed by these books is to look at the instructions for students. Following Ainley's (1988) taxonomy of questions I classify the imperatives and questions in these textbooks as *opening-up* if they suggest new areas of exploration for the student, and *structuring* if they address the student's existing knowledge. In Mathpower, for example, the authors Knill et al. (1999) ask both kinds of questions. "What is the equation of the axis of symmetry?" (p. 102) is a *structuring* question because the student is expected to already know what an axis of symmetry is. The question suggests one right answer. "Why does the graph lie only in quadrants I and II?" (p. 102) is an *opening-up* question because the student needs to connect observations about this graph to other mathematical experiences, make conjectures and test these conjectures. Responses to this question will vary in both content and depth, and thus reveal each student's level of thinking and depth of knowledge.

In Mathpower twenty-nine percent of the instructions for students are opening-up directives. These opening-up directives are more concentrated in the special graphing calculator sections than in the regular exercises. In Addison-Wesley Mathematics twenty-one percent are opening-up, mostly concentrated in the regular student exercises. Since both textbooks have more structuring directives than opening-up directives we might conclude that in both cases the model student is someone who follows directions and waits to be led into discovery, someone who does not explore mathematics independently. However, both books have at least some opening-up directives. The authors might argue that there is an optimum proportion of such directives, and that it might be better to ask one good opening-up question than to ask many. Having fewer opening-up directives might lead students into further depth of thought in their responses.

People can learn what others expect of them not only by what they are asked to do, but also in the way they are addressed. Students who read these textbooks might be shocked to find that although they are given instructions, they are rarely referred to as people. There are few reminders in these books that authors, readers or mathematicians are human. Alexander & Kelly (1998), authors of Addison-Wesley Mathematics, provide a slightly more human face by referring to themselves once in the preface: "we hope [the book] helps you…" (p. viii). They use a few personal pronouns (*you*, *your*, and *we*) in the analysed sections, but in some of their uses of *we* the pronoun does not refer to anyone in particular. The pronoun seems to refer to anyone who knows the one and only correct procedure,

and seems to suggest that the student reader ought to aspire to this knowledge. For example, "We use a negative number for Ymin [the screen's minimum *y*-value] so the horizontal axis appears above the coordinates at the bottom of the screen" (Alexander & Kelly, 1998, p. 85). Rowland (1999) describes such a usage of *we* as authority masquerading in the guise of solidarity (p. 19). In the analysed sections of Mathpower, Knill et al. (1999) do not use any personal pronouns. In both books the passive voice is predominant.

How might a student respond to this passive-voiced assertion: "The parabolic path of the aircraft can be represented by the quadratic function $h(t) = -10t^2 + 300t + 9750$" (Knill et al., 1999, p. 126)? The reader might wonder where this representation comes from. Who says that the function is a fair representation? How did they come up with this representation? Why would they want a function to represent the height of the aircraft? Why is this important to me? Any one of these questions could be the beginning of a meaningful discussion about mathematics, but instead, the reader is likely to have no questions. The absence of human beings in this representation of mathematics suggests that this function just "is". The function seems to exist as fact whether or not a human decides to consider it.

Morgan (1996) warns that the passive voice obscures the presence of human beings and thus affects the students' picture of the nature of mathematical activity (p. 6). The model reader cannot be blamed for believing that humans have no role in constructing mathematics. The student's only hope is to understand pre-existent mathematics and to follow pre-determined procedures. The model reader seems less than human – more like a computer, idle until it receives its unambiguous instructions.

It seems obvious to me that the teacher is a significant person in the mathematical education of most Pure Mathematics 20 students. Surely the textbook writers know this. Strangely, neither textbook acknowledges the presence of teachers at all! Not only are the student readers constructed into a world of submission to inhuman authority, but they are also led to ignore the people around them – their teachers and classmates.

Yet another clue to books' model readers is their use of pictures. Both textbooks under consideration have relatively few pictures. Dowling (1991) suggests that such books imply a model reader who is relatively high on the socio-economic scale, ready for the rigour of challenging procedures, uninterested in distraction.

In Mathpower's quadratic functions chapter sixty-three percent of the pictures are of TI-83 calculators (fourteen TI-83 screen images, one TI-83 calculator, nine pictures of other things). One of these pictures is an eleven by five centimetre picture of a TI-83 graphing calculator with the brand name graphically removed (Knill et al., 1999, p. 102). Why modify the picture? If the authors are ashamed to identify the type of calculator, why did they choose a particular calculator at all? In the comparable chapter in Addison-Wesley Mathematics eighty-eight percent of the pictures are of TI-83 calculators (twenty-nine TI-83 screen images, thirteen small pictures of TI-83's, six pictures of other things). The model student constructed by both textbooks seems to own a TI-83 graphing calculator, and "needs" the calculator for certain important tasks.

Both books, Mathpower and Addison-Wesley Mathematics, imply a model reader whose personality is left behind when doing mathematics and who follows predetermined procedures when instructed to do so. The types of instructions together with the predominance of the passive voice encultures students into this submissive approach to mathematical thinking. Addison-Wesley Mathematics allows a glimpse of the human face in mathematics, and Mathpower invites a little bit of creative thought from its readers, but generally both books paint a picture of mathematics that is static and unchanging no matter what perspective from which it is viewed. The pictures favour Texas Instruments products and also remind students to ignore "outside" interests in their rigorous work – again, to close off their own experiences from their mathematical thinking.

A Teacher's Response

Considering the model reader constructed by both textbooks, what is the role of a good mathematics teacher? As a teacher, if I mandate a particular book, I feel that I need to model critical

reading for my students. Love & Pimm (1996) in their discussion about ways of looking at mathematics textbooks point out the inherent authority of the text and remind teachers and students that together "their responses to it may range from taking it for granted to seeing their role as challenging and criticizing it (to interrogate and even deconstruct the text)" (p. 380).

One way for me as a teacher to deconstruct the world constructed by the textbook is to focus attention in my classes on the human face of mathematics. When discussing any mathematical topic I can discuss with my students the choices made by textbook authors and the choices made by curriculum writers. Besides bringing to awareness mathematics' human face, such discussion can also help students consider the relative importance of various mathematical activities. If I tell students about the history of mathematics, and ask them questions about why particular mathematical conventions might be as they are, students will be reminded that mathematical thinking is a human activity – an activity in which they can participate creatively.

In the face of textbooks that influence students to rely upon faceless expert authority, I can guide them in their exploration of other sources of authority. I can give my students more opening-up directives, which lead them to make their own conjectures and to find ways of testing these conjectures. I can ask my students to use their own mathematical thinking, their own logic, to test their conjectures. When appropriate, I can suggest that students practice asking useful questions of their trusted but fallible neighbours – their teachers, classmates, families and friends.

I suspect that textbook publishers hope for a society encultured to submit to faceless expert authority, for books are a primary source of such authority. It seems obvious to me that the Texas Instruments Corporation can only benefit from resources that assume students have TI-83 calculators. So, I close with a shocking set of statistics (see table 1) that motivates me to resist the textbooks' constructions of a model student. I share these thoughts with you, my reader, in the hope that you consider, as I have, ways in which you can lead your students in mathematical thinking that recognizes the human face of mathematics and is not dependent on external authority and specific technology.

	Gross Annual Revenue (2000)	Percentage of Countries in the World with Annual GNP less than this Revenue
McGraw-Hill Ryerson (publishers of Mathpower 20)	$6.4 billion	38%
Pearson Education (parent company of Addison-Wesley)	$8.7 billion	45%
Texas Instruments Corporation (makers of TI-83, T-83+, …)	$17.6 billion	56%

Note: GNP projections are based on 1997 GNP and historical GNP growth rates.

Table 1

The two corporations who publish the textbooks authorized for use in Pure Mathematics 20 classes and the corporation who manufactures and promotes the calculator favoured in these books draw huge amounts of money from us, their market. About half of our world's countries have a Gross National Product that is less than the income of any one of these three corporations. Clearly, these corporations exert tremendous economic power. The influence their products have on our students can be seen as an extension of their economic power. These corporations seek profit. We can hardly trust them to make healthy student development their primary concern.

Corporations who strive for profit cannot be relied upon to serve their customers' genuine needs. By contrast, teachers are more trustworthy because they set goals in the context of their relationships with students. I do not wish to suggest that teachers who use the authorized textbooks or

TI-83 calculators in class are endangering their students. Instead, I hope to draw attention to the need for teachers who relate with students and engage them in dialogue about mathematics, and the related technological and social issues. With thoughtful use these books and calculators can be valuable resources in a healthy mathematics classroom. Although mathematics textbooks seem to assert that the human influence of teachers is unnecessary, I submit that teachers are indispensable.

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