TEACHING FROM YOUR TEXTBOOK MANUSCRIPT

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Abstract: I will discuss opportunities, pitfalls and other lessons collected as I used my calculus textbook manuscript as a primary source for students in both Calculus 1 and 2. Much of what is written here applies also to typewritten lecture notes. There is probably little or nothing here that would surprise most readers who have pondered this, though it may have some value in being verified through experience.

1 Introduction

It is not uncommon for faculty to complain about the textbooks available for their courses, but writing their own is a massive undertaking not entered into lightly. For all of their faults, mainstream textbooks usually have the advantages of having passed through many hands in the writing, editing, testing and production process. And yet faculty still find faults.

In order to rectify these faults, faculty can supplement the texts, on occasion correct the texts, not use any texts, or take the plunge and attempt to write their own. When choosing this last option they can embrace the advantages over the available texts, but must also give some homage to the strengths of those texts by being aware of the disadvantages of writing their own texts, and minimizing those, or at least those that matter most.

In this piece I explain my own experiences in using a manuscript from the single-variable calculus text I began to write after wanting to do so for years, and that, while not yet finished, I have used now in various stages of completeness a half-dozen times over a rather embarrassingly long thirteen years, hoping that the fourteenth year is "the charm." Despite its various stages of fit and finish, I have found many advantages in using it as the increasingly primary source for my students, and they seem none the worse for it when they take subsequent courses from other instructors. For instance, my last such use of it was a Calculus 1 class in Spring, 2012, and those students are now (Spring 2013) in Calculus 3 with another professor and performing very well, as they did in Calculus 2 in between.

2 What I Do

For my Calculus 1 and 2 courses, I assign reading and homework from my textbook manuscript—provided free to the students—and, to a lesser extent, from the department-

adopted textbook by Larson and Edwards, as assigned for Calculus 1–3. My textbook manuscript is typeset in LaTeX using the book class and several excellent add-on packages (pstricks, multicol, enumerate, caption and amsmath come to mind) and so its pages look like finished textbook pages. There are no "answers in the back" or index, and the table of contents is not given out since it is always changing due to revisions of later material, but otherwise it resembles a finished mathematics textbook, albeit a black and white text without "realistic" figures. In other words, it more resembles a more advanced mathematics textbook, but a textbook nonetheless. The course's outline, when I teach it, is set by my manuscript, especially at the start of Calculus 1 where it is very different from the usual calculus textbooks, though all of the required topics are covered.

It is not the primary purpose of this paper to delve into the differences between my textbook and others, but it is notable that they are substantial: my book begins with symbolic logic, in order to make more sense of proofs, especially ϵ-δ proofs for continuity (which appears before limits); limits are pursued in more of a "forms" spirit from the outset; derivative applications including graphing occur quickly instead of being deferred until more skills are developed; infinitesimals are stressed over Riemann sums; many more examples are given for integrating techniques; and some complex analytic function theory is given with the Taylor series. A draft which incorporates some but not all of these (particularly leaving out most of the work on infinitesimals) can be currently found at `http://faculty.swosu.edu/michael.dougherty/book/book.html`.

Class is four days per week, fifty minutes per day. At the start, homework is collected and questions answered. Next I hand out copies from the next section of my book in progress, three-hole punched, usually produced from a home printer (more on that later). I then lecture on that new section and assign new homework. On a web page I post the schedule as it evolves, complete with homework assignments, due dates, and links to copies of PDF files of the handouts in case a student misplaces a handout or has to be absent.

Grading is based upon homework and occasional quizzes, four or five midterm exams (in class, fifty minutes each), a comprehensive final, and a grade for their notebook binder.

3 Notebook Binders

The binder grade, I have found, is quite valuable. While it is in effect only a grade for organization, it forces students to keep all of their materials collated by topic. Since my manuscript is not in bound form, this also helps students to keep that material together in a coherent way.

Knowing it will count for a grade, most learn to keep the material organized as they go, so the binder is easily turned in with each exam (and quickly checked for organization), though some only organize it shortly before the exam. A typical binder will eventually have, in the following order, the course syllabus and introductory handouts (for instance, a table of Greek letters), Section 1.1 from my manuscript, classroom lecture notes on Section 1.1 material, graded homework from Section 1.1 material, the same from Section 1.2,

Section 1.3, and so on, Exam 1 material (review handout, graded exam, key), and so on for the next topics and exams.

In fact, by the end of the semester most students have two or three binders, because of the volume of material generated. Each time it is turned in, I only grade the binder on the material relevant to their current exam, and have the (relevant) binder turned in with each exam.

4 The Good

I have found many advantages to using the manuscript I generated for the course. Most of these come from the fact that the person who "wrote the book" is also the one giving the lecture. This can add coherence, efficiency, and some new dimensions to the course experience for both students and author.

I should first point out that for my personal style of textbook writing, I am much more detailed in my examples than are mainstream texts, which have to answer to many different masters, including the page counters. In fact it is probably because of these page counters that, in the past, I felt as though I was filling in the details on the board, to make the department-chosen textbook material more digestible for our students. In other words, the textbook was the skeleton and my lectures the meat, at least for the explanatory parts. With my text I can reverse that.

Indeed, because I have more examples and details in my text, I can use more of an outline at the board, stick to the main points and yet still be more conversational. Of course anyone who has taught calculus knows that there are a great many interesting, (pardon the pun) tangential points—both analytical and historical—that can be made to bring it to life, but these can be distracting from the main thrust with the time scarcity of a class lecture, particularly to students intimidated by calculus and its pace. Many of these points can be instead detailed in either paragraphs within the text (say, following an example which contains more insight than might first catch the eye), or perhaps in footnotes, which have become somewhat of a lost art.

In fact no art need be lost, because the manuscript is whatever the author decides to make it, at least until a publisher gets involved. Even then, fortunately there are many small publishing houses, or even university presses, willing to publish innovative texts. Stories of mainstream publishers wresting creative (and copyright) control from authors abound, but while it is in manuscript form there is tremendous freedom.

Another advantage for me of using my text is that I obviously know it well, and it is what my students are (ostensibly) reading. I can therefore more easily refer to the text in lecture, and I do not have to reconcile what I think is the best method or presentation with that which is in the text. Also, when students read my text they quite likely are "hearing my voice," as opposed to some distant authors they will likely never meet (although there is likely some advantage to having them "hear the material from many voices").

Conversely, when I make revisions to sections not yet passed out, I can "see" my audience, because I am working with them almost daily. I am reminded naturally of what I want to tell them, and what method is most likely to help them to learn that material. Not to be overlooked is that having a class to prepare the work for provides some built-in deadlines.

Also important is that I can use the text for other purposes than just teaching them the material. For instance, I make an early effort to help them learn to read and eventually write mathematics: the logic, the notation, equation reference numbers and the like. Most if not all calculus instructors likely wish students would learn, or simply choose, to show more details, so I do so in my textbook to set the example, to the point that they can "curl up and read" the expository parts.

Not to be ignored is that if the manuscript is well written and edited, students tend to think the author is brilliant, and somewhat brag about taking the course from him or her. This can be a bit embarrassing, but is certainly tolerable.

Having a web presence for the text can also get some attention from elsewhere. I do get email on occasion from all over the U.S. and U.K. from students who stumbled upon the text in a web search.

Finally, and to some the most important "plus," is that I am essentially classroom testing the manuscript. Thus I get much student feedback and the occasional good ideas, both spontaneous and inspired by the classroom discussion. (One integration "trick" I learned came from a question from a "C" student.) Students will often naturally edit the work, and more than once I have had students bring in lists of mistakes—mostly typos—in the work. Of course this is a great help for cleaning up the manuscript.

5 Warnings

There are several snares to avoid when presenting a textbook manuscript as the main source for the course.

First and foremost, it is essential that the work is well edited. It does not necessarily have to be perfectly edited, but it should not be sloppy. It is therefore perhaps more time consuming than one might imagine at first. I was warned of this from a Penn State colleague before I thought about writing my own text. He was very dissatisfied with his department's chosen text for Differential Equations, the authors of which took none of his advice but included him in the acknowledgments. He therefore decided to make his own, typed notes to base the course upon. Unfortunately he had enough mistakes in those notes that his student evaluations had comments wondering why they had to suffer through his notes when they had "this beautiful book" required by the department.

While having a class schedule to produce natural deadlines is a plus, it is also tempting to stall a subject in order to buy time for the next subject's notes to be written or better edited. A few incidents of this phenomenon and one can become quite behind in the schedule. While not ideal, sometimes an author simply has to tell the students that the typed notes

will come later, or not at all, and in the meantime they will have to rely on the lecture notes or the department's assigned text, where applicable. On occasion I have passed out preliminary versions, on a different color of paper (usually green to represent not quite ready), to keep things moving. It should still be reasonably well edited, though students can forgive if it is not quite complete.

If another text is used along with the manuscript, that can cause problems for those students who dislike having more than one source. Learning a single subject from diverse sources is an important skill for them to develop at some point, but it can be a source of anxiety for some in a course. (A few others will see the value in it.)

It is very important that students not feel like guinea pigs. They must feel that they are better off having the manuscript handouts than not. This can come in the form of extra credit for working some of the problems in the manuscript, or being convinced it has worthwhile explanations.

I was somewhat afraid my coauthor, John Gieringer who came on board much later in the project, would run into this problem of students feeling like guinea pigs when he began to use it in his classes at Alvernia University in Reading, Pennsylvania. As there are no "answers in the back of the book" yet, he divided the exercises evenly among different halves of his class. They were given credit for those they completed, and except for the usual complaints about how much homework they did for the whole course, in fact they were somewhat excited to be part of the process. However, that may have been different if the work were riddled with mistakes.

A common pitfall many authors, including myself, have to avoid is having the text move out in strange directions. A kinder way to put this may be "being too innovative." Ron Larson related to me in an email how his first attempt was "a marriage of calculus and FORTRAN," which was a trend of thought at the time. "Mercifully," he wrote, no publisher wanted to publish his completed manuscript. So instead he eventually settled on a table of contents very similar to Leithold's text at the time, and got several offers to publish it, and the rest is history. I found myself writing over eight pages of chemistry and electrical theory so we could explain some integrals involving batteries, capacitors and inductors. My text is already innovative enough—beginning with symbolic logic for instance—and so where it indulges my interests, it still cannot distract from its main purpose: the teaching of calculus.

It is also important to allow enough time to "revise and extend." For the first few years, I was not happy with my limits coverage though it seemed reasonably complete. Finally one summer I was staying with some extended family overseas and had the time and motivation to start that topic over completely. It had to fit with the continuity sections as well, but in the end it was (in my opinion) both innovative and much stronger than the original version, in particular in how it prepares students for asymptotics needed for graphing, and l'Hôpital's rule later. My series chapter was actually my first written, but after my chapters on earlier topics were taking shape it was clear the series chapter no longer fit the style that emerged.

A nontrivial factor in all this is that it costs a considerable amount of money to give the handouts to students. I would not suggest having it be only available online (they will print them up anyhow, probably single-sided and possibly at even more expense to the

university), and would not want students to miss out on the Notebook Binder experience, so handouts to me are a necessity. However, department chairs are often alarmed when the copy bills begin to appear. If a text is completely ready for production, a university press or printing service can have it available in the bookstore. If the author wishes to do as I have, and revise the text as the course progresses, handouts need to be produced regularly, and again this costs money, at a rate which will get the attention of administrators. My solution is to simply produce them at my own expense, at home. While I originally used surplus (obsolete) analog photocopiers purchased cheaply at auctions, currently I use a Hewlett Packard inkjet printer, which can print on two sides. While the cost is not trivial, it is worth it for all the benefits, such as readability and convenience, not to mention lack of departmental red tape. At times the department has purchased printing supplies for me, in particular pre-punched paper by the case. It would not be unreasonable for them to purchase cartridges, though that makes it difficult to keep separate printing supplies used for the classroom and those used for home use. To avoid all such questions I simply choose to produce them on my own.

Lastly, to do this well takes a tremendous amount of time for those of us who do not produce books for a living. As I explain next, those who do have learned some good techniques, though how applicable they are to a mathematics textbook author is not always clear (see below).

6 My (Writer/Editor) Sister's Advice I Never Took

Upon hearing that I was well into a book writing project, my older sister, herself having written for, edited and supervised many book projects, gave me some advice. In retrospect it is very good advice, though this book being somewhat a "labor of love," it was not taken entirely. It has somewhat inspired my planning, to the extent that occurs, but it is presented here simply in case it is useful to other authors.

First, she told me I should have a "book map." The term should be self-explanatory. However, just the table of contents for a calculus book is itself a project, as there are many orders to put topics, despite the industry preferring only a couple. Furthermore, ideas for reorganization can continually present themselves as the book unfolds. In fact I have found myself several times forcing myself to abandon this or that plan when I finally realized that there was another scheme that better leveraged the advantages I believe I bring to the project. The limit reorganization mentioned earlier was one. Another was when and how I incorporate the various graphing techniques: by the time my "applications of derivatives" chapter occurs, all that is left for graphing techniques is the second derivative insights and a bit on the asymptotes which are neither vertical nor horizontal (and possibly nonlinear). It took a bit of "thinking out of the box" for me to accept that that was the best approach for me and my textbook (now "our" textbook, with the addition of my co-author). If I had produced a "book map," I might not have allowed myself that innovation. However, if I needed to produce fifty books per year—albeit "farming out" much of the writing to other individuals—I could see a book map being essential.

Second, and equally important, is to have deadlines. Again this is somewhat unsatisfying because new ideas keep brewing, and quite possibly some unanticipated idea which appears when writing about Taylor series inspires some rewriting in the derivative sections. Indeed, while it did not happen in this order to me, an author could find himself or herself wanting to do more preliminaries with symbolic logic after some series tests, or if wanting to do more with ϵ-δ proofs. It is perhaps easier to work on deadlines if one has already involved a mainstream publisher, particularly if advance payments have been received, but they have been known to take much—even most—creative control from authors. (I have stopped talking to most of them, because it seems all that they want to know how my book compares to Larson's or Stuart's, which tells me it will look like Larson's or Stuart's when they are done with it.) Also, using the manuscript with a scheduled course helps to produce deadlines anyhow, even if they are of a softer variety. Promotion and tenure pressures produce long-term deadlines as well, though again there are other ways to achieve promotion and tenure. Perhaps one of the best deadlines is simply being tired of not having the project finished. Then again, perhaps not.

7 Conclusion

If an author has a textbook manuscript which is developed enough that large portions of it can be used as a primary source in an actual course, it can be very satisfying to so use it. It makes the lecture time much more pleasurable for the instructor and engaging to the students. It can help students to relate to the material better because they already relate to the author. Unfortunately this type of classroom innovation is much underutilized, particularly given the technological tools for publishing (particularly LaTeXand its packages) that have been both free and available for over two decades. The apparent lock that mainstream publishers have on choices has stifled some of this innovation, though they are masters of editing, production and marketing. Of course students pay for each name in the credits for such a textbook. An in-house produced work can be much cheaper, better tailored to student needs, and more efficient and natural for the instructor to teach from.

At the same time, the author does have to put in enough time and work to overcome the obstacles of such an approach. Some of these may be technical—as I learned when I spent a few days learning to make a computer package work to draw professional looking electrical circuit diagrams—but most are more about the persistence to keep the project moving forward, and the creative energy needed to produce an interesting and coherent work. Fortunately, if it is done well, students and others involved respond positively, and ultimately the rewards are worth it.