

Configurable Materials For Teaching Mathematics

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Abstract This article describes a freely-available management system for mathematics materials which can be easily configured by the instructor. It was developed in the course of creating alternative texts for students in “Developmental Mathematics.” A major design goal was that the materials be usable at three different levels: **(i)** By instructors with a priori no interest whatsoever in L^AT_EX and who just want to use the materials out of the box; **(ii)** By instructors willing to learn enough L^AT_EX to be able to choose other, and/or to create new, materials; and **(iii)** By instructors proficient in L^AT_EX who want to use the system to develop their own ancillaries.

1 Introduction

Most of the students entering two-year colleges are required to take “developmental mathematics.” However, since their inception around thirty years ago, developmental programs have failed to show any measure of success, presumably because the textbooks available commercially are invariably based on “show and tell, drill and kill.” This lack of successful texts would then seem to be a powerful invitation for the development of alternative, more “reasonable” texts. Up front, though, the task of developing such texts is rather daunting.

The first hurdle is to gain acceptance from teachers. Developmental mathematics teachers might be willing to consider alternative texts, but, understandably enough, they tend to be suspicious of untried novelties. Thus, a text that does not come ready with ancillaries, e.g. homework, quizzes and exams, has exactly zero chance of even being looked at.

The challenge is then to provide an easy-to-use system to customize the materials. But if, in mathematics, L^AT_EX is the typesetting program of choice, the question immediately arises as to how the author can develop, and the user can manage, the ancillaries. As it happens, of course, L^AT_EX also includes facilities for

programming but, unfortunately, these are a bit esoteric and add to the already steep learning curve facing the prospective author.

Finally, after the author has overcome all this, there remains the even more unfortunate fact that *teachers*, who are the most likely prospective *users*, generally have zero interest in learning L^AT_EX. But if the teacher can be provided with the text, the homeworks and even the quizzes in pdf form, and if s/he might be willing to use the exams available in pdf form *once*, s/he is certainly not about to re-use them the next time around. This is where the L^AT_EX issue comes in since requiring teachers to adjust code to specify the ancillaries they want to print is a non-starter.

Several years ago, I began developing materials to be used by “unprepared incoming students”, and to be freely available under a GNU Free Documentation License. This article is about my attempt to overcome the odds and provide a system that teachers would use.

2 Installing the pieces

The first major obstacle when attempting to convince people to try interactive materials that have been developed in L^AT_EX is to convince them to install the L^AT_EX system. It is as if one asked people to install L^AT_EX just to read a letter one had sent them. In the latter case, of course, we rely on their pdf reader but, in the case of ancillaries, when L^AT_EX is to be *used interactively*, we *need* them to get a L^AT_EX installation. *That* is a big problem, perhaps the main one.

Indeed, if, with T_EX Live, things have become a lot simpler for the *author*, its sheer size remains a powerful deterrent for the potential *mere user*. This seems to be something very difficult for L^AT_EX aficionados to understand. The standard response is a shrugging “different L^AT_EX documents require different packages so T_EX Live includes as many as possible.” To repeat, while this makes it indeed simpler for the *author*, it looks like an absolute overkill to the *user*, one which s/he does not understand. What is really needed for the use of specific L^AT_EX programs is an “invisible installer” to be bundled by the *author* together with the L^AT_EX program and all necessary packages. The *user* would then just download the bundle and one-click to install.

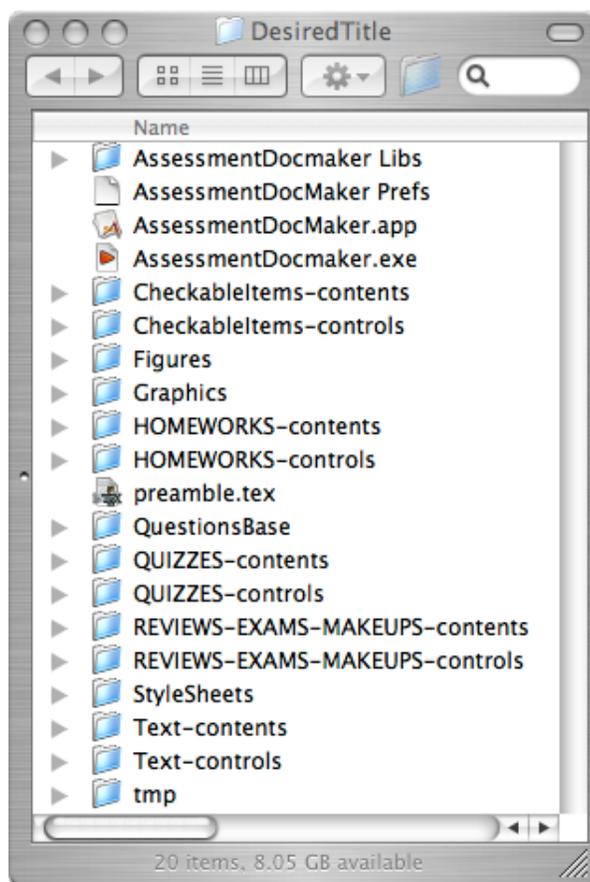
Currently, the procedure for the teacher who wants to use DesiredTitle is:

- i. Download and install T_EX Live from <http://www.tug.org/>

ii. Download and unzip the single folder which contains all the files for DesiredTitle¹ from <http://www.freemathtexts.org>.

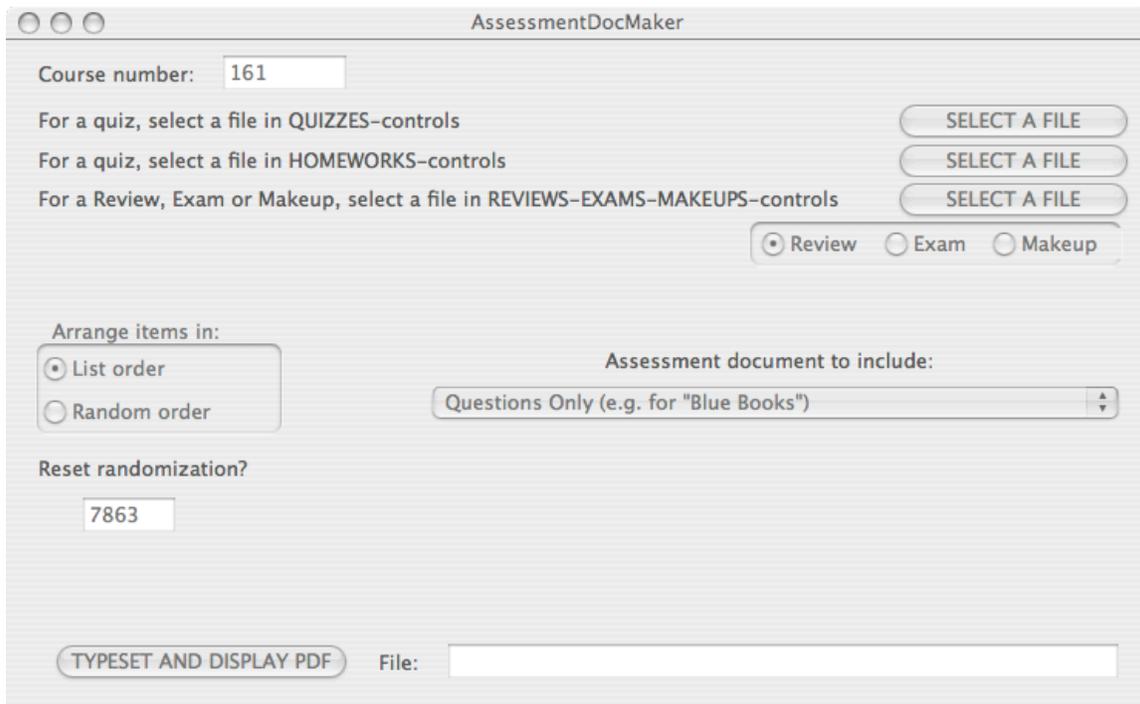
3 Using Ancillaries Out Of The Box

No matter what DesiredTitle is, here is what the user will see when s/he opens the folder:

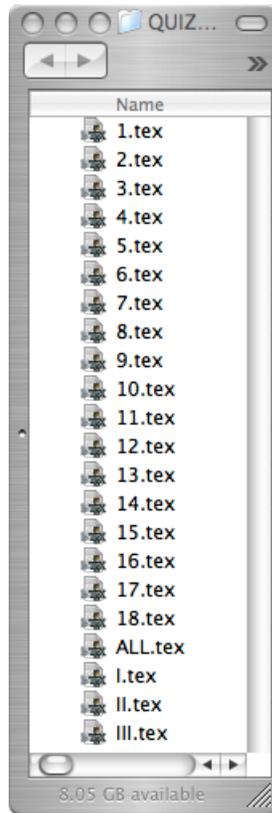


and all s/he has to do is to double-click on the appropriate AssessmentDocMaker (ADM)—which must remain in the folder DesiredTitle but can be placed in the dock—to get:

1. The stylesheets are in the folder StyleSheets, where \LaTeX will automatically find them. See below.



which it is simplicity itself to use: The user enters the course number the first time around—ADM will remember it—and, depending on the kind of the desired assessment document, say a quiz, clicks the corresponding SELECT A FILE thereupon ADM automatically opens the QUIZZES-controls folder:



After the user has selected the desired quiz, s/he checks whether she wants the items in the quiz arranged in List or Random order and possibly resets the randomization. Finally, using the pulldown menu, s/he sets which one of the following the quiz ought to include

- Questions Only (e.g. for Blue Books)
- Questions With Spaces For Open Responses
- Questions With Discussions
- Plain Multiple Choices - Grid On Separate Front Page
- Plain Multiple Choices - Grid Alone On Front Page
- Plain Multiple Choices - Questions Start After Grid
- Plain Multiple Choices - No Grid
- Supported Multiple Choices - Grid On Separate Front Page
- Supported Multiple Choices - Grid Alone On Front Page
- Supported Multiple Choices - Questions Start After Grid
- Supported Multiple Choices - No Grid

- Answer List
- Answer Key

Say s/he wants the Answer Key. After clicking on TYPESET AND DISPLAY PDF she gets:

MATH 161 QUIZ 4 Answers

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 [Run: 06/16/2010 at 16:48. Seed: 6477. Order of Checkable Items: Random.]

Answer Key:

Question	a	b	c	d	e
1					
2					

NOTES

1. The reason Review, Exam, Makeup are lumped together is to ensure that the same “checkable items”, that is the same type of questions, be used, if possibly in different orders, in all three documents. While this feature is likely to cause cries of “Teaching to the test!”, it: (i) can be avoided if desired² (ii) turns out, in the appropriate context, to be a powerful incentive for the students to read pencil in hand and try to understand why they are doing what they are doing, and, last but not least, (iii) causes no discernible grade inflation.

2. As for the choices in the pulldown menu, they become obvious as soon as one has seen the outputs. For instance, should one want just to collect the (response) grids but leave the questions with the students, one would format the assessment document with “Grid On Separate Front Page”. In the case of a quiz, though, one might want to choose “Questions Start After Grid” so as to save a tree. Etc.

4 Customizing And Using From Source

The general idea was to separate things according to the probable frequency of their use with things getting more remote from the user as they were less likely to be used.

2. However, considering the currently standard reliance on “template examples” ...

Thus, the separation of *contents* from *controls* in the main folder's file structure was based on the fact that user-interaction with the *controls* were bound to be markedly more frequent than with the *contents*: the first thing users would want would be to set things such as, say, multiple-choice in list order versus open response spaces in random order or, say, whether to print the *questions* for the students or the *answer key* for themselves which, by the way, involves only commenting/uncommenting a number of commands. This structure antedated ADM which, in fact and as I understand it, talks only to the control files which then talk to the contents file.

There is however a second level at which the user might want to control the ancillaries. For instance, a user might prefer, say, to use the term "Exercise" rather than the term "Quiz" or might want to change the size and/or appearance of the space left for open responses. Since this is a deeper level, the corresponding renewcommands were relegated to StyleSheets/QuizConstructionParameters.sty.

As for the heart of the system, it is isolated in StyleSheets/AssesmentDocumentConstruction.sty but there is little for me to say here about it: either you know L^AT_EX and you can go and take a look by yourself or you don't and you won't care about it to begin with.

5 Modifying The Contents

After a while, and no matter how perfect the out-of-the-box materials, any teacher worth her/his salt will want to play around with the contents which is of course why the L^AT_EX source is available and the point of the GNU Free Documentation License.

In the case of the text itself, there is of course no problem other than for the user to learn the various formatting commands.

In the case of the ancillaries, though, things can be quite a bit more complicated depending on what changes one wants to make. The overall structure is that, for each one of the eighteen chapters making up the text, there is in QuestionBase a folder with up to fifty checkable items that can be used in the corresponding homework and quiz and on the exam³. To see the list of checkable

3. Any number can be added just by copying the template 0.tex and numbering the files.

items for, say, Chapter 5, one opens and typesets CheckableItems-controls/5.tex⁴.

For instance, here is the top of RAFv4-1/CheckableItems-controls/5.pdf:

Ch	File	Description	Qz	Hw	Rt	Rs	Ex
5		Positive-Exponent Power Functions					
5	1	Gvn I-O Rule, gvn \pm Lrg inpt, Sign-Size outpt =?		✓			
5	2	Gvn I-O Rule, gvn \pm Sml inpt, Sign-Size outpt =?	✓	✓			✓
5	3	Gvn I-O Rule, gvn \pm Lrg inpt, Place Loc Gr = ?		✓			
5	4	Gvn I-O Rule, gvn \pm Sml inpt, Place Loc Gr = ?		✓			
5	5	Gvn I-O Rule, Loc Gr nr $\pm\infty$ = ?		✓			
5	6	Gvn I-O Rule, Loc Gr nr ∞ = ?	✓	✓	✓	✓	✓
5	7	Gvn I-O Rule, Loc Gr nr 0^\pm = ?		✓			
5	8	Gvn I-O Rule, Loc Gr nr 0 = ?	✓	✓	✓	✓	✓
5	9	Gvn I-O Rule, odd +coef, Glb Gr = ?		✓			

where, for instance, the second line specifies that the checkable item in the file RAFv4-1/QuestionBase/5/2.tex is “Given an input-output rule, given \pm small inputs, what are the sign and the size of the outputs?” and that the available versions are for the quiz, the homework and the exam.

For each checkable item, there is in turn a file in QuestionBase which includes one version of the checkable item for the quiz, one for the homework, one for the review and several for the exam. Each version can have the multiple-choice answer and/or a “discussion”.

Here is the top of RAFv4-1/QuestionBase/5/2.tex, showing the version for the quiz and the top of the version for the homework:

4. With TeXShop on Mac, one can also open and typeset the contents file instead of the control file.

GraphicsPath.sty lets L^AT_EX find them. The numbering system is such that the subfolder structure is unnecessary but the latter is convenient enough.

- The QuestionBase folder contains one subfolder for each chapter with each subfolder containing fifty copies of a form in which to fill-in the versions of the checkable item. The line

```
\xdef\CheckableItem{\finkdir-\finkbase}
```

on top of each checkable item file ensures that all of the versions throughout each have a single specific name as required by the probsoln package.

- The contents folders contain individual chapter files as well as a file ALL.tex whose purpose is to assemble the chapter files into a single file.

7 Results And Feedback

Given the particular nature of the two-year college culture,

Among community college faculties, unlike university faculties, social organization does not follow the academic/intellectual organization. The elevation of teaching over research or scholarship may have turned faculty into 'generic teachers,' but it also stripped away any intellectual norms that might bind them together. And so they search for commonalities, or in any event don't raise matters they see no rational way to resolve.[...] They come to undervalue intellectual exchange and mutual criticism, and to overvalue 'sharing' as sources of professional and organizational development.

Mc Grath, D., & Spear, M. B. (1991). *The Academic Crisis of the Community College*. Albany: State University of New York Press

I was not expecting too much and didn't get much at all. As someone once noted on <http://mathforum.org/kb/message.jspa?messageID=4669795&start=0>

I have some doubts whether the concerns of Urner, Geissinger, and Schremmer are on target, but I listen to them and share their disappointment. Trying to promote change in cc faculty is frustrating. Not only is there little reaction, but there is a continuation of practices and policies that are directly associated with unacceptable levels of student learning.

With some notable exceptions (some of them on this list) most cc math faculty simply ignore the larger picture of our failure. 50% retention rates in watered-down courses is disastrous to our personal, professional, and national interests.

Maybe a listserv is not the proper place to address this failure. However, it seems to me that it should be the focus of everyone teaching in a cc.

the inertial forces seem overwhelming.

The surprising thing, though, is that the number of downloads of Reasonable Basic Algebra has steadily gone up in the near three years that it has been available. By now it is about a thousand a month. And this is with a rather unwieldy management system which the present one, including ADM, is to replace shortly. The other available title, Reasonable Algebraic Functions, has yet to be entirely uploaded.

As for *my* students, they fall in two categories: They either hate it or love it. See <http://www.ratemyprofessors.com/ShowRatings.jsp?tid=633910&page=1>.

It should go without saying that I would be most interested to hear from readers who would want to try either Reasonable Basic Algebra or Reasonable Algebraic Functions with their students. In fact, Dax Mickelson has a forum at <http://www.daxm.net/freemathtexts/> dedicated to FreeMathTexts.

And, equally of course, I would be glad to help those wishing to develop their own teaching materials with the management system presented here. They should contact me directly at freemathtexts.org or via the forum.

8 Thanks

The first thing that needs to be said here is that the heart of the system is Nicola Talbot's `probsoln` package. All I did, as I have absolutely no understanding of \TeX , was to tinker with it on the sole basis of extended trial and, mostly, errors. Moreover, I should mention that Dr. Talbot, from the School of Computing Sciences, University of East Anglia, was kind enough, on several occasions, to bail me out of the unfathomable holes I had dug myself in, and even to do quite a bit that I should have been able to do myself. For instance, it was she who wrote the code for creating the response grids as I didn't have a clue. Without her, there just wouldn't have been any system.

The next thing I must say is that the only reason the users of the titles on FreeMathTexts.org have ADM, this most elegant Graphic User Interface is that Michael Sharpe, from the University of California, San Diego, whom I had met on the TeX on Mac OS X Mailing List, took pity, if perhaps not on me, at least on my prospective victims. Out of the clear blue sky, or so it seemed, he sent me the first version of ADM to debug, warning me that it would not work. But a few days later, my own incompetence notwithstanding, there it was, in all its "simplicity". It should be noted that it works under Windows as well as under Mac OS X.

Last, but certainly not least, there is this very article which I started a couple of years ago by writing a lot of stuff going nowhere. But I was lucky. There was this editor who put up with my cantankerous idiosyncrasies and my delays, kept me on the path with incredible patience and eventually succeeded in making me write an *article*. So, here is to Lance Carnes to whom I am thereby offering the position of Editor for all the texts on FreeMathTexts, unpaid but with the privilege of final cut.

And finally of course, there are all the people I acknowledged in <http://www.freemathtexts.org/Acknowledgments.php>. As I concluded there, "Without *all* of you, the world would have been spared this."