

# **Designing Courseware with Maple, (without expecting the students to learn Maple)**

**Mike May, S.J.**  
**Department of Mathematics and Mathematical Computer Science**  
**Saint Louis University**  
**221 N Grand Blvd**  
**St. Louis, MO 63108**  
[maymk@slu.edu](mailto:maymk@slu.edu)

When one decides to use a CAS package like Maple to teach mathematics attention needs to be paid to the method used to incorporate it into classroom practice. The best method will vary depending on factors unique to each institution. In particular, one has to decide how much one intends to explicitly teach Maple to the students. This paper outlines a method found effective by the author in a variety of courses that has the students using Maple to learn mathematics while only requiring them to learn a minimal amount of Maple. This method should easily be adaptable to many other institutions.

## **First consideration – Appropriate Mathematical Material**

Any discussion of producing course material for a mathematics course should start with the mathematical material. The question of how to develop material to teach with Maple need to be modified to look at what kinds of mathematical material might be taught more effectively with Maple. (Unless enough such material is found in a course, the obvious answer to the first question becomes that the course is better taught without CAS.) The author finds that Maple may be used to advantage when the material calls for visualization, when the students would be helped by exploration of examples that the students will find computationally challenging, when the organization of the lesson calls for focusing on results of a computation before focusing on the computation itself, and when the lesson calls for working with complicated examples or data sets that are not tractable by hand computation. To give a specific example, the author found it effective to teach a chapter on sequences and series by beginning with a Maple activity that showed how sequences of Taylor polynomials wrapped down to the function they were approximating. By focusing on the result of a visual demonstration using series and convergence of functions before the students had mastered or even formally been introduced to the topics, the class obtained a framework that made the difficult

computational work easier to understand. Less dramatic is the majority of the material in multivariable calculus, which is made clearer with visualization.

### **Second considerations – The local reality**

The next set of considerations deal with the details of the institution where an instructor is trying to incorporate Maple into a course. Relevant issues include the availability of hardware and software for the students, the technical sophistication of the students, the number of courses that a typical student will use Maple in, the quality and availability of technical support on campus, and the goals of the course. The central question that these other issues circle around is how much formal Maple instruction should be included in a given mathematics course and how much Maple skill can reasonably be assumed by the instructor. At one extreme, it is not unusual for an engineering school to decide that their students will use a particular CAS package as a standard tool for all courses. In such a case, the school may decree that the first year mathematics course is where they will be taught the package. The investment of time in one math course is justified by results in later courses. Toward the other end of the spectrum, the author uses Maple in a number of courses that will be the last mathematics course for the majority of the students in the class, and most of the students have never used a computer in a previous course. Simply put, the author's situation dictates that he can use Maple to teach mathematics only if he can do it without requiring the students learn Maple.

The rest of this paper focuses on structured worksheets as a method of incorporating Maple into a course without assuming that the students learn Maple. Instructors who find they can require more Maple skills from their students should modify their teaching materials appropriately. It also seems normal that the best approach will evolve, even at a fixed institution, if hardware or software becomes more available, or if Maple becomes a routine part of a significant part of a curriculum.

### **Models for teaching with Maple**

For the rest of this paper it is assumed that Maple is being incorporated into a course in a way that does not require the students to learn any significant Maple skills. In particular, the median student will be assumed to have learned less than 10 commands at the end of a course using Maple. As mentioned above, one model for doing this is the use of structured worksheets. There are, however, several other models for effectively using maple in this setting. It is worthwhile to explore them briefly before looking at worksheets in more detail.

**Simple free use by the student** – While Maple can do much more, it is a good calculator and grapher. This mode of use is available to the students if they can be taught the plot command and graphing calculator syntax for functions. The author's experience is that if an instructor wants students to use these features “whenever they are useful”, the instructor must get the students started by occasionally stopping class and pointing out to the students that they should produce a graph whenever a function is being discussed. It

is also useful for the instructor to model the desired behavior by using Maple in class whenever a calculator or grapher is called for.

**Simple free use by instructor** – As mentioned above, this may be called for simply to encourage the students to use Maple appropriately. For example, this method of use would be called for in multivariable calculus if the taught that whenever one did a problem with a function of 2 variable you should start by looking at a graph to aid intuition.

**Canned demo by instructor** – This method can be thought of as using Maple to produce a slide show that will be used in class with the added benefit that the slides can be tweaked in class in response to questions. The author has found it useful in dealing with “doing a fast clean presentation of the difficult problem had us confused last class.”

**Canned demo run by the student** – This method can be thought of as using Maple to produce supplemental material that will be accessed outside of class time. This may be called for if one is producing Web pages for a course.

**Structured worksheets used by the student** – This is the normal way the author uses Maple in a variety of classes. The assumption is that the students will obtain worksheet files over the local network, and either do them in class or for homework, either printing out hard copies or returning the files electronically.

### **Rules for constructing structured worksheets**

Experience in teaching shows that questions of structure are best answered with examples available. The author’s worksheets can be found at <http://euler.slu.edu/Dept/Courses/Coursewaredevelopment.html>. Having produced more than 50 worksheets for a variety of courses, the author suggests the following rules for producing effective worksheets.

- 1) **Include enough text to be self-explanatory** – The ratio of text to code should be at least 6 to 1 if not much more than that. Enough mathematical development should be included that the students can do the worksheet without referring back to the book or notes.
- 2) **First pass execution should only require the return key** - To be user friendly, the worksheets should be stored so that initial code is executed simply by repeatedly hitting the return key.
- 3) **Include exercises on everything** – Using Maple does not change fundamental human nature. If students believe they can complete an exercise without reading or understanding, at least some of them will try that. The assignment should include exercises on all major aspects of the material covered.
- 4) **Raw Maple output should never be a correct answer** – The students should be required to at least interpret the output and indicate what the answer means.

- 5) **Consider the length you want the worksheet to be** – Students will take longer than you think to get through the material. The author tries to make worksheets that will take an average student about 1 1/2 hours, so that they can get started in class, but must come back a second time to finish. If you aim at this length be careful to explain to the students what happens if a worksheet is restarted in the middle.
- 6) **Start worksheets with the restart command** - Students will routinely move from one worksheet to another so that the Maple session has variables defined in unpredictable ways. The restart command returns Maple to a standard condition.
- 7) **Test the worksheets on machines the students will use** – Lab or classroom machines often have less memory than the machines on faculty desks. Lab and classrooms also tend to have other programs that can create “interesting features” when running software. It is better to test in advance than to find out about the problem after making an assignment.

### **Reflections on implementation**

Another side to consider is how to use the worksheets in a course. The author has used them successfully, both as an in class activity and as an out of class assignment. Your experience will vary with the nature of the students at your institution. The following bits of advice on implementation seem useful:

- 1) Prepare a very simple introductory worksheet – Although the worksheet model reduces the set of Maple skills the students need, it does not eliminate them. In particular, students need to be able to open, save, and print files. They need to be able to add insertion points for both text and code. They need to know how to enter commands that take more than one line. They need to know how to copy and paste. The author uses a worksheet named “Just enough Maple” to introduce students to using Maple. In every course he has taught, this worksheet has been needed by some students.
- 2) Do the first worksheet in class – Even if the worksheets are generally to be done as homework, and there are no computers in the classroom, it is worthwhile to schedule time in a computer lab for the first worksheet. This shows the student where everything is and lets the instructor know what kinds of problems the students are having with using worksheets. The “as a class session should be followed within a week with an assignment that requires them to do a worksheet without the instructor present.
- 3) Have students work in pairs – The author’s experience is that the students learn faster if they have to share machines and talk to each other.