Using SageMathCell and Sage Interacts to Reach Mathematically Weak Business Students

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In addition to a "business calculus" course, it is frequently required that students in business, economics, marketing, finance, accounting, and management take a course called *Finite Mathematics* in the USA, or *Quantitative Methods* in the UK. These courses often cover an assortment [1] of topics, including financial mathematics, combinatorics/probability/statistics, and problem solving with systems of linear equations, matrices, Gaussian elimination, and linear programming.

The topics of modeling with systems of linear equations and linear programming (systems of linear inequalities) are often traumatic for these students, who have weak mathematical skills, poor study habits, and little motivation. This talk will highlight some successful strategies that the speaker has used in teaching *Finite & Financial Mathematics* at the University of Wisconsin—Stout, a polytechnic located in the midwestern USA. In particular, the use of the computer algebra Sage [6], in two forms, was tremendously successful. Sage is the free and open-source competitor to Maple, Mathematica, Matlab, and Magma. Because Sage costs nothing to use, it is attractive for use in this present era of general fiscal distress worldwide.

At the start of the class's exploration of systems of linear equations/inequalities, a Sage "Interact" (a kind of app or interactive webpage) is used to model an industrial situation. To paint a clear picture, it is useful to describe this one "interact" in full detail at this time. An old factory is to be decommissioned, and a final production run will be ordered to consume as much as is possible of existing dangerous supplies. Any unused supplies must be disposed of resulting in disposal fees which might be catastrophically expensive. The students can move sliders to find a production schedule that must not use more supplies than actually exist, but that hopefully uses up "a lot" of the dangerous supplies. Usually a room full of 40 students, each experimenting on a laptop, will have a range of solutions resulting in disposal fees of around 5,000,000 to 500,000 dollars. Then a linear system of equations in four variables can be derived by the instructor, which solves the problem exactly—and which results in disposal fees of 0 dollars. The students see that knowing how to solve a system of linear equations will save the company between 500,000 and 5,000,000 dollars, and this makes them motivated to pay attention

[1] For a syllabus, see `http://www.uwstout.edu/mscs/upload/MATH-123.pdf` as an example.

during the start of this critical chapter. The reader is now invited to experiment with this interact, to be found at [1], before reading further in this abstract.

After such an introduction, students will begin to read solutions of longer problems, and then attempt to solve problems on their own. Typical American textbooks will have problems of two, three, and at most four variables during these two topics (systems of linear equations and linear programming) [3], [4], [5], [7]. The problems often are unrealistic, with "round numbers" to facilitate solving the problems by hand. In stark contrast to this, the speaker uses detailed problems with realistic numbers, many variables, and many equations/inequalities. Those would be unpleasant or nearly impossible to solve by hand. However, using SageMathCell, the systems can be easily solved. Moreover, SageMathCell works through the web-browser[2], and therefore the students do not need to install anything.

During this talk, the speaker will present the above example, and then two or three other examples used in his teaching. The result of using computer algebra tools in this manner is that the course is transformed from focusing on the mechanical actions of performing Gaussian Elimination and the Simplex Method into one where students read complex problems, and then must model the problems as a system of equations or system of inequalities. While challenging, modeling industrial and commercial phenomena is more intellectual and a better preparation for the modern workplace.

While the speaker is not in a position to run a controlled experiment to prove the efficacy of these teaching methods, there have been several benefits in his own classroom. The students are more engaged, more likely to attempt the homework problems, they score higher on examinations, and they give the instructor better teaching evaluations. Moreover, the faculty members of the College of Management at the speaker's university have gone from expressing grave concerns to praising the mathematics department.

References

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