BUSINESS COLLEGE ALGEBRA:
INCORPORATING EXCEL, THE INTERNET, AND BUSINESS EXAMPLES

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Acknowledgements – This work in an extension of previous work, Business Calculus with Excel (BCE), a one-semester calculus course for business students. BCE was in turn inspired by a previous ICTCM award winner (2001 Baltimore), Networked Business Mathematics (NBM), by Bob Richardson and Brian Felkel, from Appalachian State University. NBM is currently available from Kendall and Hunt Publishers. The current project is partly supported by NSF Award No. 1625142, "A National Consortium for Synergistic Undergraduate Mathematics via Multi-institutional Interdisciplinary Teaching Partnerships" in which each of 11 institutions is looking at Math and a Partner Discipline. SLU's partner discipline is business.

History, Part 1:Other Business Calculus Projects– As mentioned in the acknowledgements, one of the roots of this project was the work on designing a one semester calculus course for business students that is actually designed for business students. The typical commercial text for such a course is designed for students in both business and life sciences, a spectrum of students so broad that all of the students feel the course is not particularly relevant for them. The texts also tend to be technology agnostic. For both these reasons, the texts tend to concentrate on symbolic manipulation skills and applications template as short word problems that can be presented within the confines of a few sentences.

Two projects made serious attempts to produce a book that was designed from the ground up as a business calculus book. The first was Networked Business Mathematics (NBM), by Bob Richardson and Brian Felkel, from Appalachian State University. NBM is currently available from Kendall and Hunt Publishers. That project used Excel as the main computational engine for the course. The examples were heavily tilted to things that a student might see in a business class. However, the authors moved on to other priorities in their careers. The textbook was also designed assuming students would be in a computer lab with the CAS Maple available. The reasons for arguing that business students should be taught math with Excel also argue against teaching it with proprietary software that is not readily available in most business settings. We are not aware of any schools that are currently using NBM.

The other serious Business Calculus Project was Mathematics for Business Decisions (MBD) by R Thompson and C Lamoureux and Arizona. The text is available from the MAA. This text is designed for a team taught course, jointly taught by business and math faculty. It assumes that grading will be done based not on tests, but on group projects where the math is applied in a business setting. We are not aware of any schools that are currently using MBD. Inquiries to schools that used the text reported that it was dropped either because a change in attitude by the business school wanted a more traditional calculus course, or the team-taught approach could not be sustained when the original instructors moved on to other projects.

History, Part 2: Business Calculus with Excel– The BCE project at SLU attempted to build on the NBC project. There were several ways that the background had changed which led to a change in the course design:

1. Between 2001 and 2010, laptops became common for students.
    a. The course could be done in a traditional classroom rather than a computer lab. It also meant that laptops would be assumed to be available all the time, rather than just for lab days.
    b. If the students have web-connected laptops available all the time, they should be using other resources that are freely available on their machines. Maple was replaced by Wolfram|Alpha or Symbolab as a tool in the course.
2. At SLU, the course is typically taught by adjuncts and teaching assistants, and the resulting project had to be sustainable using those resources.
    a. Material on using Excel is explicitly in the text along with sample worksheets.
    b. The Excel functionality used is limited to an amount that students can remember. No macros or programming is used.
    c. While the text is online, in many ways it is a traditional textbook mathematically. For the most part, the calculus is similar to what is in a traditional textbook. (There is the addition of a thread using data to build best fitting functions of an appropriate model.)
3. Better connections with business.
    a. The book attempts to use "Good Excel Practice", where the students build worksheet templates from scratch. Students are trained that a good worksheet should be easy to follow and sufficiently documented.
    b. The ongoing discussions with the faculty of the business school have led to a rich collection of business related examples and motivation.

More detailed reports on this project are available in the ICTCM Archives, 2011, and 2014. The text has been open sourced, using the PreTeXt system. At SLU, it is currently used in 6 sections a semester, primarily taught by adjuncts and teaching assistants. The instructors universally report they are no longer fighting with students about why they need to learn the material.

History, Part 3: CRAFTY– At the same time these calculus projects were being developed the Mathematical Association of America was looking at the teaching of lower

division math courses and how well they met the needs of the partner disciplines who were asking for the courses. One of the standing committees of the MAA is the committee for Curricular Renewal Across the First Two Years, or CRAFTY. In 2001 CRAFTY ran a project where they gathered groups of faculty from selected partner disciplines and asked what they wanted out of the math courses required of their students. This was done in a "fishbowl" setting, where math faculty sat on the outside and could only listen while the partner discipline groups talked. Across a wide variety of disciplines the groups came up with remarkably similar desires. The results of these discussions were published by the MAA is 2004, with follow-up information in 2011. We are particularly interested in chapter 3 of the 2004 report, which looks at business and management. Some of the recommendations were that a course for business math should:

- Use spreadsheets as the primary computational engine.
- Have greater emphasis on constructing mathematical models from data.
- Increase the emphasis on numerical methods rather than symbolic manipulation.
- Whenever possible use the terminology and notational conventions of the business world.
- Consistently use examples that the students will recognize as relevant to the courses in their major.

After the 2004 report, a number of NSF grants looked at reforming College Algebra to get closer to meeting these recommendations. Results of some of those projects are in the 2011 CUPM report.

History, Part 4: SUMMIT-P– Attempting to build on these results a group of 11 schools applied for and were awarded an NSF grant, Award No. 1625142, "A National Consortium for Synergistic Undergraduate Mathematics via Multi-institutional Interdisciplinary Teaching Partnerships." Each of 11 institutions is looking at interactions between math and a partner discipline. SLU's partner discipline is business. The plan was to locally reproduce and extend the CRAFTY discussions with regard to business by having an ongoing discussion group between faculty in the business school and the math department concerning the teaching of mathematics for business students and ways to make it more effective. In the initial planning the co-PIs assumed we would work on courses subsequent to business calculus. The group was convened and a strong consensus emerged from the business faculty that we should concentrate on a course for College Algebra for Business.

College Algebra for Business at SLU– The first pilot of the course was Fall 2017. We started by building on previous work to make a CRAFTY compliant college algebra course at VCU, another member of the SUMMIT-P consortium. In particular VCU had developed worksheets that made modeling a major theme of the course, with the work being done as group assignments. We started with their pacing and had samples of their tests. For the pilot, we used the same text that they used.

One of the shifts in bringing the course to SLU was to focus it more tightly on business students and their needs. We have enough sections of college algebra to make a business only section feasible. Relying on lessons learned in the development of Business

Calculus with Excel the class was designed assuming that students would have access to Excel and the internet unless a particular class activity required closing the laptops. Students were assumed to have Excel downloaded on their machines. While students were also allowed to use graphing calculators, the instructor used the free Desmos calculator site and answered procedural questions about Desmos. Wolfram|Alpha was mentioned band allowed, but not used by the instructor.

The choice of software was deliberate. Part of the selling of Excel comes from the business school's decision to make it part of their curriculum. The message was that the boss (or instructor) could read Excel files, and would only accept certain homework in that format. Students could work with whatever software they wanted, but had to convert to something the boss could read. In fact, other spreadsheets have enough functionality for everything done in this course. Restricting to the one spreadsheet that the business school backed made grading easier and helped in the sales pitch for the course. Desmos was chosen because a graphing calculator is the appropriate tool for some college algebra material. Desmos was deemed to be the best free product at reproducing a graphing calculator with ease of use as a factor. Making everything work on the laptop has the added background message that we are not using tools that are only used in a math class. As an added benefit, Desmos worked well for our international students who typically have not used a graphing calculator in high school. One of the surprises noticed teaching the course is realizing that students had to be trained to use a graphing tool to find answers or to explore a particular function.

About one day every other week was devoted to worksheets that required the students, working in groups to use Excel for modeling and producing functions from data. The first worksheet day was devoted to basic Excel functionality. Several other days looked at modeling data to different kinds of functions. Tests and quizzes routinely had questions that required use of Excel or Desmos.

Whenever possible the examples were tied to business courses or concepts. Lines were explored looking at functions for supply price and demand price as functions of quantity. The prime system problem was looking for the point of market equilibrium. The basic quadratic function was not projectile motion, but revenue and profit as functions of quantity. The basic examples for exponential growth and decay were not bacterial growth and radioactive decay but present of future value of a quantity over time. Use of base e for exponential and log functions was deemphasized in favor of bases like 1.04 that may show up in real work interest problems. For modeling the students built exponential models for the CPI and various stock indices over time.

Whenever possible a conceptual approach was emphasized, often using technology tools. Less time was spent on techniques of factoring polynomials and more time on the connection between factors and roots and asymptotes or rational functions.

Future plans– The pilot course was offered a second time in Spring 2018 and will be offered again in Fall 2018. We will be shifting to a different text to allow the use of an automated homework system. The students in the course showed enough weakness in algebraic skills to make the drill and feedback loop of an automated homework system

worthwhile. To make the modeling more effective students will be required to do a bit of writing to present their models and explain the strengths and weaknesses of their models. We will also be tracking the comparative success of students in the pilot vs standard course in college algebra as they go on to survey of calculus.

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