Math For Business Applications

Target audience for the course – any college student or potential student answering 'yes' to one (or more) of these questions:

1) Are you delaying taking your program's required math course because you 'might fail' and don't want to have to repeat it?
2) Are you in a program that recommends this course to fulfill the quantitative requirement?
3) Are you looking for a math elective that will teach you a usable skill (such as a spreadsheet application)?
4) Are you terrible at memorizing formulas for a math test?
5) Maybe you know all the formulas but forget which ones are used when, and want a math course that frees you from this burden?
6) Are you ready to really engage with math and don't want to avoid it any longer, provided that you have a teacher that will work with you where you are?

Introduction – Math is a subject that screams to be engaged with. Math is about ***finding*** and ***discovering*** numerical patterns in the everyday decisions that we make, our creative processes and products, and is present in the world around us. Every thinking person accepts the relevance of mathematical phenomena as fact. But, sadly, many people see the entire subject of math as this nebulous, unfathomable blob that only certain really smart people get but is "not for me". Without going into the "whys" and the "wherefores" (let's avoid going down this rabbit hole) it is the role of the college professor to ***engage students*** in the subject matter. Full stop.

So engage. I dare you.

We must take a moment to talk about the elephant in the room: computing software.
The Role of Microsoft Excel ™ , Mathway.com, and Desmos.com cannot be ignored in our modern society. The use of computing software cannot be ignored, and in fact we should arguably embrace it. Before we had the electronic, hand-held calculator people had to rely on recursive algorithms - that is they performed certain combinations of addition, subtraction, multiplication and division, over and over again, until reaching an answer to something like "the square root of 2". Calculations that now take a split second on a calculator would have taken previous generations of students many long minutes of painstaking work.

Educators have been arguing – sometimes quite heatedly – for the last half-century about what mathematics really is, and what a proper foundation in mathematical reasoning means at each and every level of a student's experience. The argument has not been settled to a large extent, though the emphasis is still placed on the middle school "algebra-geometry" sequence. We won't go into the reasons why, but suffice to say that in a free society we want every individual to be able to (eventually) learn Calculus if they choose to pursue a career that requires it. What is required is for colleges and universities to fundamentally change the way Calculus is taught, as well as what our expectations are in the form of learning outcomes. We need to completely

get rid of the "how to" type outcomes because software can do all of it, and software can perform faster than we can. What, you say? Yes. Get rid of it.

Key Differences – call it "New Old Math" versus "***Really*** New Math"

Not everyone has the same skill when it comes to memorization and algorithmic processing (putting pencil to paper and correctly following the 'steps' that 'perform' the math). Let's look at a single example that illustrates how we can embrace technology but not sacrifice the rigor – which means *learning objectives that are more meaningful* both for the learner and the educator:

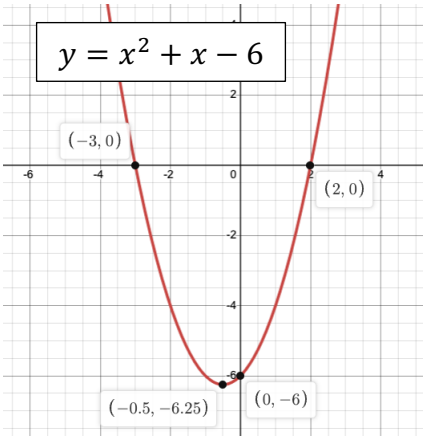
Here we see a "New Old Math" type question on a test or quiz, same old same old.

1) Solve this equation using a method of your choice: $x^2 + x - 6 = 0$

Learning Objective:
Common Core State Standards A-REI.4a and A-REI.4b, found on page 65 of this document.

Will the "***Really*** New Math" please stand up… replace ALL "how to" learning outcomes and objectives. Their only purpose is to prepare for standardized testing (which also needs to go away if learning outcomes do not align with 21st-century access to tools). Here is what question #1 would look like now:

1) Asked to solve the equation $x^2 + x - 6 = 0$ a student used a ***graphing*** tool and a ***factoring*** tool. Here were the results but the student was uncertain what to write as 'the solution':



$$\boldsymbol{x^2 + x - 6}$$
$$(x + 3)(x - 2)$$

a. What is the solution to the equation?
b. Did the student use the tools correctly? Explain why or why not.
c. What part or parts of the graph provide the solution to the equation that was given?
d. What purpose did factoring serve in solving the problem?
e. How are the factors and the graph connected?

Learning objectives for this question:
The student will ***use multiple representations*** to solve a math problem.
The student will ***interpret a graph*** or other visual display of information to solve a math problem.

The student will ***make connections*** between algebraic information, tabular information, and/or graphical information to solve a math problem.

What I'm advocating for isn't revolutionary. It's evolutionary. Do we embrace technology, or do we pretend it isn't there? Were it not for standardized testing, I am certain that math classrooms would look very different than they do right now. Were it not for a systemic reluctance to adapt our college math departments away from decades of boring Calculus lectures and toward a more engaging, more meaningful learner-focused curriculum, things most certainly would be very different today. The biggest roadblocks for change are textbook publishers at the college level. (At the K-12 level too honestly). Until we provide educators with an adaptive, learner-focused curriculum things will not be much different going forward.

The greatest contribution that was made toward this positive change (the Common Core State Standards for Mathematical Practice) did not go far enough. Too much emphasis is still placed on "how to" outcomes. It was and is criticized in school board meetings, administrative meetings, and in school communities at large. It's the age-old story really: unfunded and unsupported mandates will generally fail largely because they are thrust upon our institutions without also offering tremendous support and resources for adopting them. Here are the 8 mathematical practices that are supposed to be at the heart of all K-12 curriculum:

The learner will be able to…

1. make sense of problems and persevere in solving them
2. reason abstractly and quantitatively
3. construct viable arguments and critique the reasoning of others
4. model with mathematics
5. use appropriate tools strategically
6. attend to precision
7. look for and make use of structure
8. look for and express regularity in repeated reasoning

If these were not articulated to you, and this is the first time you are seeing them, you are not alone. Here is the 93-page document that outlines what these mathematical practices look like at each developmental level of childhood learning. Notice that there still appears to be too much emphasis on performative mathematics, and not enough on reasoning and creative expression.

In a sense, mathematics educators have been grappling with AI longer than anyone. Students can input a homework problem into mathway and their homework is done for them. Society didn't seem to care. Now we see the discipline of language arts (really any discipline that is writing-intensive), where educators are just now faced with concerns that mathematicians have been faced with already for decades. ***What to do when the software does the work for you?***

But does it…. really? And oh… ***now*** we care about it?

What software does really well (for math) is a combination of computation, tabulation, and making nice graphs. What it does not do at all is make inferences, recommendations, evaluations, and connections with the results of those computations. What follows is a narrative version of a college course in Math for Business Applications, though arguably it could be used in any Applied Math course designed as a "first course" toward either a more traditional Calculus course (without trigonometry) or a course in Statistics and Probability, or as a stand-alone college math course that fulfills the quantitative reasoning requirement.

I say 'requirement' as if it is a chore, a burden to be extricated at the earliest possible moment. To that individual, I say 'I understand'. I get it. Truly, I have seen what it does to people when they see red all over their paper despite trying their best. Before reading any further, I want you to do something (if you see math as a burden). I want you to draw/sketch a picture of yourself doing math. Try to show in your picture the emotion you feel, maybe throw in some words – like fraction or factor – that especially trigger these emotions. Take your time. Put in as much detail as you can.

Now look at the picture and say out loud 'This is in the past. I can't change my past. But I can change my future.' Your future self hasn't been decided yet. You have a choice to make. Let your past dictate who you are, and who you become. Or reject the past and make a fresh start. This will be the hardest thing you are asked to do the entire semester. Trusting yourself to engage with content and explore your *potential to be good at math*, not because you can regurgitate complicated formulas and procedures but because you will try, fail, learn why you failed, and try again. I ***dare you*** to discover that math *is* useful, that it *does have* a purpose in your life.

Are you willing to take a chance and work hard on something that may or may not pay off? Because if you are, then I am looking forward to working with you.