Designing and Using an Active Learning Workbook in Calculus 1

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1.

What is this?

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The Active Learning Workbook utilizes information from our OER course textbook, *OpenStax Calculus, Volume 1* to allow students to use the workbook to take notes in class and work on additional practice problems.

The workbook ends up becoming the student's class notes that they can refer back to as they're completing homework assignments or studying for tests outside of class.

2.

How Does This Work?

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During class I give students information and examples, and the workbook guides them through taking organized notes. Then they also attempt problems on their own or in groups.

During this time, I walk around and try to engage the students or groups of students. I check their work and guide them in the right direction. I encourage students to ask questions, or me or each other. If something could help the whole class, I bring the students attention back to the front, and give a hint or further explain some detail.

How Does This Work?

I try to use different techniques to best fit the content for each topic.

For example, in the section to the right, I allow the students to go through a series of steps to discover the idea of a derivative on their own.

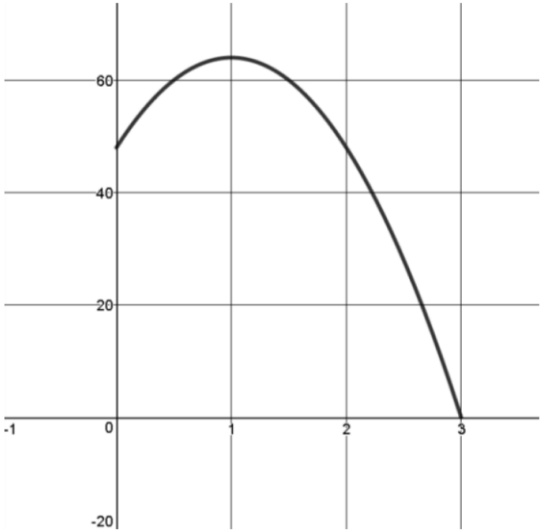
Much of this topic is adapted from the OER *Active Calculus* textbook.

2.1 A Preview of Calculus

Calculus is the study of change. When looking at any quantity that is changing, we may want to ask "how fast is the quantity changing?" To answer this question precisely, we need to use calculus.

Let's start by considering a scenario where a ball is thrown straight up in the air from some initial height.

Try It 1: Suppose that the height s of a ball (in feet) and time t (in seconds) is given by the formula $s(t) = 64 - 16(t-1)^2$. Here is a graph of this function on the time interval $0 \leq t \leq 3$.



a) Fill in the rest of the values in this table:

t	$s(t)$
0	
0.5	
1	
1.5	
2	
3	

b) In everyday language, describe the behavior of the ball on the time interval $0 < t < 1$ and on the time interval $1 < t < 3$. What occurs at the instant $t = 1$?

How Does This Work?

Another example of this is the topic Linear Approximation.

Many calculus textbooks explain this idea using a process of "imagine you zoom in on a graph".

In contrast, in the workbook, I take the students to a computer lab and let them use a graphing utility to actually zoom in on a graph.

4.2 Linear Approximations and Differentials

There are many functions where it is very difficult or even impossible to calculate certain values of a function. For example, given the function $f(x) = \sqrt{x}$ it is very difficult to find $f(3)$. However, given what we know it would be easy to find $f'(x)$.

Go to https://www.desmos.com/calculator On the left side of the screen you can enter functions and equations to graph. Type in f(x)=sqrt(x) to graph $f(x) = \sqrt{x}$. In the box below that (where there's a 2) enter g(x)=1/4x+1 to graph the function $g(x) = \frac{1}{4}x + 1$. Resize the window by clicking the wrench button in the top right of the graph screen. I would recommend the window size for x and y to be $[-3,10]$.

What relationship is there between the two functions that you graphed?

At what point do they intersect? (If you're having difficulty telling from the graph, click on the box where you entered $g(x) = \frac{1}{4}x + 1$, then scroll over the grey dot that appears at the intersection).

Do you think the relationship is the same or different now? If different, what do you think the relationship is?

3.

What are the Benefits?

What are the Benefits?

Students end up with a solid, organized packet of notes they can use and refer to outside of class.

Students have time to work through details and issues in class, while they have access to me or each other to ask questions.

Since students have already worked through problems in class, they are better prepared to tackle homework problems outside of class.

Culture in the classroom emphasizes asking questions, normalizing mistakes and working to correct them, and some struggle with the content.

What are the Benefits?
Student Perceptions

Students have indicated they like having an organized set of notes. Additionally, students have indicated that while taking notes it saves them time and allows them to focus more on the lecture material since there is already some content on the worksheets, rather than struggling to keep up writing everything down.

As students become more accustomed to the classroom culture, they do better at solving difficult problems.

Throughout the semester, students become more open to asking me questions. This becomes especially important in the later part of the course when we talk about application problems.

What are the Benefits?
Student Quotes

"I liked the use of a workbook that we followed along in rather than just teaching concepts using different examples. Having the problems already on paper helped me to keep up with what was being taught."

"The workbook was very well-organized, and made it easy to find sections when doing homework later on. It was also nice during lectures, because I could sit and listen to the professor's explanation and write as she went, rather than struggling to scribble down a problem and solution and miss the actual walkthrough of the problem like a lot of my previous classes."

"I feel that this was my best way of learning math material. Having examples following a question similar to the example helped me to understand newer material more efficiently rather than using notes that a teacher wrote down in a previous lecture."

"I liked the posts and conversations between the students and the professor. I have never seen that in a mathematics class. It is an excellent way to talk about our feelings with each other."

4.

What are the Drawbacks?

What are the Drawbacks?

Since students have more time in class to actively engage with the content, there is less in-class time for giving information or showing examples.

How to Overcome?

Thought needs to go into every part of the workbook (and subsequently how class is organized). Every example the instructor does and every problem the students do needs to have a purpose to maximize the time you have.

What are the Drawbacks?
Student Perceptions

Students have indicated that they have some anxiety working with other students. Math anxiety (and social anxiety) come into play. Many students don't like working with other people or asking questions.

How to Overcome?
Student Perceptions

Creating a positive classroom culture is important to help students feel more comfortable working together and/or asking questions.

Normalizing mistakes as part of how you learn can also help students feel more comfortable.

5.

How could Something Like this Work in a Non-Math Discipline?

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Students need organized and helpful notes in any course.

Some ways to create a workbook could include:

- ✗ Providing vocabulary lists for students to define.
- ✗ Providing an outline of each class sessions lecture for students to fill in.
- ✗ Providing an outline of reading material for students to fill in.
- ✗ Providing talking points or case studies for the students to discuss amongst themselves.

6.

How does This Work Now, in Our COVID World?

How Does This Work Now, in Our COVID World?

Since COVID started, the course has been online (second half of Spring 2020) and hybrid (Fall 2020 and Spring 2021). In both those instances the workbook still helps students stay organized.

In Spring 2020, I made videos of my “lecture” portion of the course, then students worked their problems using our OER homework management system, MyOpenMath.

In Fall 2020 and Spring 2021, I held many classes by Zoom and/or in-person (or both). The workbook was a great way to keep the students engaged in the content without having to re-design the entire course to make it work.

7.

Sources

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