

Title: Concept mapping in introductory calculus class.

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Often students in the Introductory calculus class find it difficult to understand the connection between different concepts like a function and derivatives, or between the limit of a function as the independent variable tends to a certain value and continuity of the function at that point, etc. They seem to get confused with what aspect leads to what behavior, or how to predict the graph of a function using the derivatives, etc. I have been struggling to make these connections using examples and problems, when I read about the concept mapping project done by Dwight Atkins*. I simplified and improvised this idea to suit my students and tried it out in my class for this project.

By introducing the concept mapping strategy in my class regularly, I wanted my students to be able to:

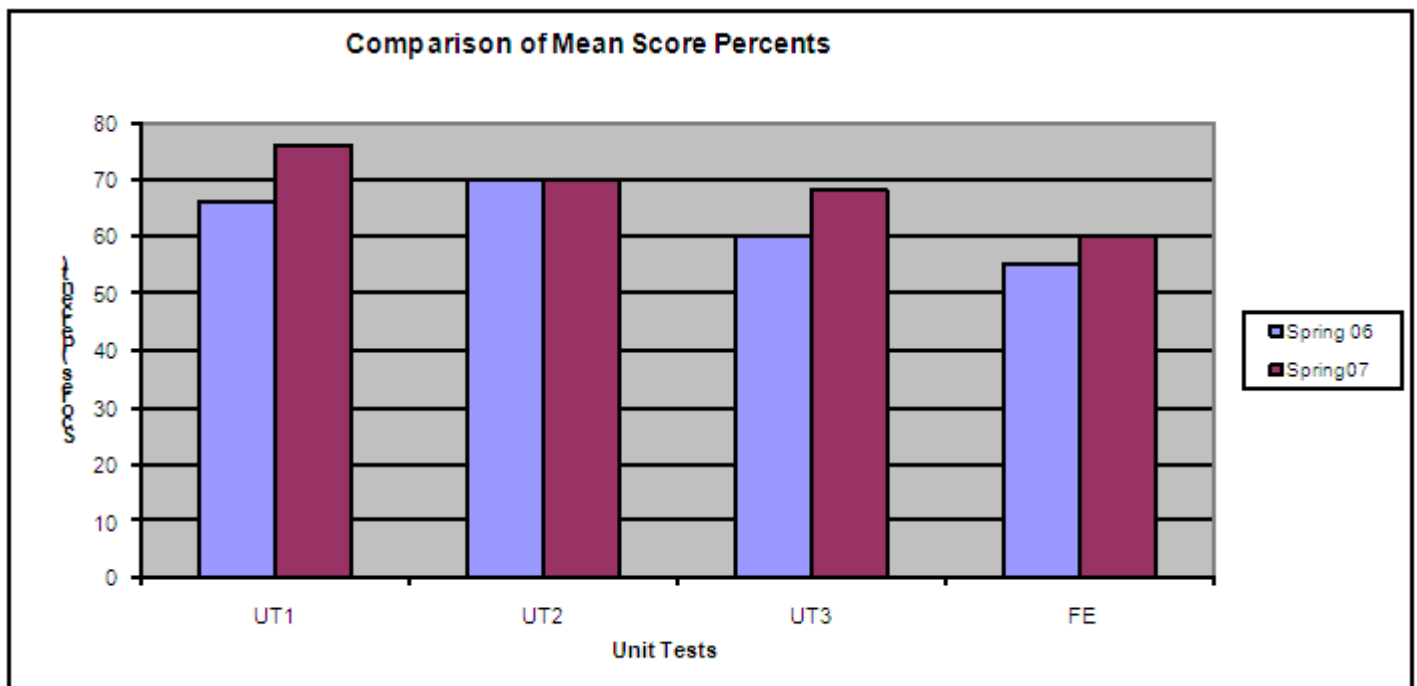
1. Understand how the concepts of limit, continuity, and differentiability are connected
2. Sketch a function using its first and second derivatives
3. Explain the behavior of a function, given a sketch of its first derivative and second derivative functions
4. Solve real life problems using the concept of derivatives.

I planned to investigate the effect of this strategy by:

1. Comparing the mean percentages of scores on the unit tests of this spring semester with the respective topic unit tests of the previous spring semester.
2. Student attitude survey responses.

At the start of the semester, I explained how I planned to use concept mapping for this course. Subsequently, I drew the mapping on the board after each sub topic, and later on asked students to develop an appropriate mapping for the topic, connecting all the subtopics. After a while, I assigned developing maps for sub topics also, for bonus points. The bonus point strategy worked well with most of the students. Since the mapping strategy was enforced throughout the semester, I planned to analyze the influence of this strategy by comparing the mean (percentage) of the three tests and the final exam with the corresponding three tests and the final exam of the previous semester. In addition, I included questions to investigate students' opinion about concept mapping strategy in the semester-end student attitude survey

Comparison of mean scores on the three corresponding tests mixed results showed that, While there was an increase in the mean for Unit Test 1 (66 to 76), the means for the Test 2 were approximately equal (70 for both) whereas there was a decrease in mean for the Test 3 (60 to 68). Nevertheless, the final exam scores averaged slightly better than the previous year's final exam scores 55 to 60). These scores did not include the bonus points offered for the mapping assignments, as these were added only to obtain the final percent for determining the grades. Although students showed no apparent improvement in performance after the first test, there seems to be an overall positive effect, as confirmed by the responses of students to the relevant questions in the student attitude survey. The not-so-good comparison could be due to various factors like the occasional concept tests that distracted and 'frightened' students, etc. I hope to integrate concept mapping more rigorously and regularly next semester, and strive to get more benefit from this strategy.



Student attitude survey responses examples

- Concept maps were useful, and I was able to easily recall them in my mind at test time.
- Slightly difficult, somewhat helpful
- Kind of confusing at times. Takes some explaining to be able to understand
- Seemed sort of complicated and confusing
- These didn't help me learn any more material
- Outlining works better for me
- Helped because they were bonus points
- I didn't like some aspects of it but overall a good idea
- I felt that this could have been useful, but it was hard to understand where the information came from
- I think it should have been explained a little more

From responses of students to the question asking them about their opinion of the concept mapping, I arrived at the following:

- About fifty percent of the students found this strategy useful in remembering the connection between different concepts. But only about thirty percent were able to apply these connections to solve problems.
- Almost thirty percent of the students experienced difficulty drawing the concept maps, based on the examples provided by me.
- The other twenty percent did not understand the utility of concept mapping and felt concept mapping assignments were an extra burden on them, and did not help in clarifying ideas.

Based on my analyses of the student responses and comparison of their performances in the tests with the respective tests scored by students in the previous year class, I came up with the following revisions to be incorporated in the future classes:

- Introduce concept mapping for conceptualization of topics in addition to enhancing procedural insight. This means that I should try and teach topics using concept maps instead of using them to summarize the results. For doing this, I would need to draw concept maps connecting students' previous knowledge to the new knowledge.
- Make concept maps an integral part of my calculus course, by including them in my class activities.
- Encourage students to do concept maps and benefit from them by including these in unit tests.

** Concept Maps is an article written by Dwight Atkins of Surry Community College. It is published in Assessment Practices in Undergraduate Mathematics (page 89)*

Reference:

Atkins D. (1999). Concept maps. In *Assessment Practices in Undergraduate Mathematics*. (Editors: Bonnie, G., Keith S.Z., & Marion W.A.) *MAA Notes Number 49*. Mathematical Association of America, Washington, EC.