MATH 143: Week 13 - Monday's In-Class Exercises
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Lesson Plan: "Exponential Equations and Functions"

Overview:
In this lesson our focus is the introduction of exponential functions and equations. First, we'll kick off by solving exponential equations to get comfortable with the idea of working with symbolic representations. where the variable is a power instead of a base. Second, we'll begin to connect the symbolic and graphic representations: given a symbolic representation of an exponential function, we'll plug in values of x to generate a set of ordered pairs to construct a table and then sketch the graph along with the asymptote. Third, we'll analyze and evaluate "real-world" situations with exponential functions, and use examples based on topics that I know are used in calculus. Finally, we'll conclude the class with a "post-Test 2" / "pre-Final Test" self-reflection response that aims to exercise students' metacognition.

Course Learning Outcomes (CLO):
Through in-class exercises and out-of-class exercises, successful students who pass this course will be able to:

1. **[CLO #1]** Apply and manipulate varied representations (i.e. symbolical, graphical, contextual, and tabular) of algebraic expressions, equations, inequalities, and functions to solve problems and puzzles in diverse contexts.
2. **[CLO #2]** Create algebraic functions with specific, important features such as: axis intercepts, degree, leading coefficient, asymptotes, rates of change, input and output, maximum and minimum, inverse, composition, domain and range.
3. **[CLO #3]** Analyze "real world" data with a regression analysis to estimate relationships among variables and make predictions. Such analyses will include scenario-based problems in disciplines such as business, science, engineering, and/or elementary education.
4. **[CLO #4]** Analyze a specific problem in a scenario and/or context in order to construct a written argument composed of complete English sentences, algebraic statements, and/or logical statements that reasons and explains:
    i. Why a particular strategy, conclusion, and/or solution is appropriate.
    ii. How the various components or ideas are related, connected, and/or organized.

Lesson Learning Objectives (LLO):
Through the in-class exercises, successful students who participate in this class period will be able to:

1. **[LLO #1]** Analyze the symbolic representation of an exponential function with linear and quadratic exponents in order to solve for a single variable.
    i. In alignment with: CLO #1
    ii. Fink: integration, foundational knowledge, application
2. **[LLO #2]** Evaluate the symbolic representation of an exponential function in order to generate a set of ordered pairs to construct a table and then sketch the corresponding graphical representation along with the asymptote.
    i. In alignment with: CLO #1, CLO #2
    ii. Fink: integration, foundational knowledge, application
3. **[LLO #3]** Analyze an exponential function in the context of a "real world" word problem in order to obtain solutions and make observations.
    i. In alignment with: CLO #1, CLO #2, CLO #4
    ii. Fink: integration, foundational knowledge, application, caring, human dimension
4. **[LLO #4]** Analyze their current "post-Test 2" and "pre-Final Test" situation and in order to construct a written argument composed of complete English sentences that reasons and explains:
    a. What were the "easiest parts" of Test 2 for them, and why they think they were easy? What actions or strategies did they use to train and "make them easy"?
    b. What were the "hardest parts" (muddiest points) of Test 2 for them, and why they think they were hard? In retrospect, what actions could they have taken to make such parts "easy"? How do they plan to make improvements?
    c. How they plan to prepare for the remaining 3 weeks of the semester, the upcoming final, and the next math class (if applicable).

d. At least two examples of how the skills they've learned in the class may help them in their career (or beyond).
    i. In alignment with: CLO #4
    ii. Fink: integration, foundational knowledge, application, caring, human dimension

Prior Knowledge:

- Last week we had Test 2, which covered various families of functions but did not include the family of exponential functions. We haven't touched any topic related to exponential functions in class, and this is due to the fact that I decided to pause the MLC group activities based on exponential functions because I wanted the students to first focus on mastering topics associated with rational functions and regression analyses. This decision is based on various assessments, as well as their Aleks statistics. I believe that the students could benefit from pushing these exponential topics back a couple of weeks. For example, in terms of general mastery of the total Aleks pie on 2011.11.10, the semester is approximately 75% complete (over 12/16 weeks complete), but only:
    - 2/16 of the students have mastered at least 75%+ of their Aleks pie (both of these students actually completed their pie), and
    - 9/16 of the students have mastered at least 60%+ of their Aleks pie.
- On the date of writing this lesson plan (2011.11.10), the following is a list of class mastery for the given Aleks topics:
    - Solving an exponential equation by finding common bases (quadratic exponents): 13%
    - Solving an exponential equation by finding common bases (linear exponents): 44%
    - Graphing an exponential function and its asymptote: 19%
    - Finding a final amount in a word problem on exponential growth or decay: 19%
- All students should have had some limited exposure to exponential functions near the end of their previous Math 108 class (or equivalent), but such topics are not nearly as in depth and it would have been at during approximately week 14 of last semester (at the earliest).

Situational Factors:

- There are 16 students in Math 143 along with 17 students in Math 108, so it will be a full class in a lecture classroom (i.e. not a computer lab classroom) designed to fit at most 42 students. The Math 108 students will sit on one side of the room, and the Math 143 will sit on the other side of the room so they can work in groups and so the instructor can target one audience at a time with my mini-lectures, feedback, and assessments.
- The single whiteboard is relatively small for this class size, so the whiteboard material will need to be clean and organized for students to see it.
- The class is from 6pm to 7:15pm, so it is an evening class when many of us are tired and have been working all day. (Note: as always, motivation and interactive exercises will be important to keep people active and working.)
- A relatively large percentage of the class is nontraditional students (in contrast to my previous experience of morning and early afternoon classes).

Lesson Procedure:

- **Introduction and Review**
    - ***Exercise Type*:** Mini-Lecture Semi-Active Activity
    - ***Learning Objective Alignment*:** LLO #1, LLO #2; CLO #1, CLO #2
    - ***Estimated Time*:** ~5 minutes
    - ***Routine:*** Instructor will:
        - Recall the various families of functions, and explain that we're working on a new family of exponential functions.
        - Emphasise that many of the same rules apply to exponential functions, but clarify that in these exponential functions: the base is constant and the power is variable (whereas in previous function families the base is variable and the power is constant).
        - Mention that exponential functions are in some sense "opposite" to logarithmic functions, which we'll discuss later.

        - Mention that this will be essential for future math classes such as calculus.
- **Basics of Exponential Functions and Equations with Applications**
    - ***Exercise Type*:** Mini-Lectures, Think-Pair-Share Interactive Activity and Informal Assessment
    - ***Learning Objective Alignment*:** LLO #1, LLO #2, LLO #3, LLO #4; CLO #1, CLO #2
    - ***Estimated Time*:** ~60 minutes
    - ***Routine:***
        - Students will:
            - Form groups of 2-3 and begin collectively working on think-pair-share exercises to analyze exponential equations and functions.
            - Make observations and connections between symbolic and graphic representations of exponential functions, and compare and contrast various observed results. Experiment with the input-output of exponential functions by generating various ordered pairs in order to construct tables of data and sketch graphs (by hand and with calculators) in order to build a strong visual sense.
            - Have the opportunity to interact with the instructor and other students by asking questions and participating in various mini-lectures.
            - Not submit these particular exercises for assessment, but instead will be assessed by the instructor via walk-by observation.
            - Be given the answer key to their exercises after 45 minutes has elapsed, so they can compare their answers and self-assess, and ask additional questions for 15 minutes.
        - Instructor will:
            - Do mini-lectures between both Math 108 and 143 classes.
            - Ask questions and engage students (informal assessment).
            - Physically “walk by” the students to observe their performance and progress (informal assessment).
- **Post-Test 2 and Pre-Final Test Self-Reflection and Metacognition Exercise**
    - ***Exercise Type*:** Individual Interactive Activity and Formal Assessment
    - ***Learning Objective Alignment*:** LLO #4; CLO #4
    - ***Estimated Time*:** ~15 minutes
    - ***Routine:***
        - Students will:
            - Reflect on the “easiest parts” of Test 2, and analyze/explain thought process of actions, strategies, and results.
            - Reflect on the “hardfest/muddiest parts” of Test 2, and analyze/explain thought process of actions, strategies, results, improvements, and planning for the future.
            - Reflect on skills learned in the class so far, and analyze/explain thought process of “real life” career (or beyond) applications.
            - Work will be submitted for an ungraded formative assessment.
        - Instructor will:
            - Walk by and observe student progress and performance (informal assessment).
            - Look over the submitted reflections in order to observe student thought process and make future lesson plan decisions (formal assessment)