Skills Development in STEM Tutoring (5/9)

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Overview

- STEM tutors facilitate skills development with their students
- Many skills apply to STEM, despite misconception that the skills apply to writing and humanities
- There are unique subsets of skills that apply for STEM coursework
Note Taking

- Annotating STEM lectures/textbooks/problem sets
  - Often need to make special note (e.g. highlight) of certain formulas/rules
  - Problem sets involve repetition of content, and often include exceptions to rules that should be noted
  - Just like essay assignments build off of lectures and assigned readings, STEM exams build off of lectures and problem sets

- Good note taking leads to more productive academic support sessions in STEM
  - Easier to work through issues in the material when students have taken thorough notes on the content
  - Lecture notes and review of those notes act as context for problem sets and practice exams
Test Preparation

- Practice exams are fundamental in STEM courses for succeeding on exams
  - Professors often make practice exams for their students, and if they do not, they can distribute other professors’ past exams for the course
  - Tau Beta Pi (TBP) has a past exam database for a majority of STEM courses
  - The Math Department also has a past exam archive
  - Our tutors can relay this important information to our student athletes

- “Cheat Sheet” creation is an important skill for test preparation in STEM
  - Many classes allow students to bring in a page (sometimes front and back) to the exam
  - The professor will give specific regulations on the sheet
  - Making the sheet serves as test preparation itself
    - Deciding what material is most important and why
  - Common test prep strategies (flash cards, study guide, time management, etc.) apply for STEM test prep
Reading Strategies

● Reading through STEM textbooks
  ○ PDP
    ■ P: Look for background information on what will be learned
    ■ D: Highlight key points, write down any boxed formulas or theorems
    ■ P: See how example problems translate to other exercises in the book

● Reading to self-teach online STEM courses
  ○ Examples: Psych W1, Stat W21, Stat x10
    ■ Can be difficult to go through a course without formal structure
    ■ Tied into time organization skills
  ○ Distill what is important in online learning materials and translate into personal set of “lecture” notes

● Understanding and interpreting homework/exam questions
  ○ Many STEM exams will have questions that give a brief paragraph before the question is asked. This can be full of important information for the problem, or could be completely irrelevant
  ○ Example on next slide
Writing Strategies

- Clear presentation of logic and work in STEM is critical
  - When a professor or GSI cannot follow your work, you will lose points
  - Many STEM courses have concepts that require diagrams/structural drawings
    - Ambiguity in these diagrams and drawings leads to confusion

- Formalism in math
  - Specific structural form of writing out math problems
  - Leaves no room for ambiguity
  - Ensures students approach mathematical thinking from a rigidly logical perspective
    - Step 1 (start with what you know), then “it follows then that” Step 2, until “therefore” the answer
9. (25 points) Find the general solution to the following differential equation

\[ y'' + 2y' + 2y = x \sin(2x) + x^2 \]

Solution:

**First solve** \[ a^2 + 2a + 2 = 0 \]

\[ a^2 + 2a + 2 = 0 \quad \Rightarrow \quad a = -1 \pm i \quad \Rightarrow \quad r_1 = -1, \quad r_2 = -1 \]

\[ r_1 = 1 \quad \Rightarrow \quad y_c(x) = c_1 e^{-x} \cos(x) + c_2 e^{-x} \sin(x) \]

Let \[ y_p(x) = A x \cos(2x) + B x \sin(2x) + C \cos(2x) + D \sin(2x) \quad \Rightarrow \]

\[ y_p''(x) + 2y_p'(x) + 2y_p(x) = (4A - 2B) x \cos(2x) + (-4A + 2B) x \sin(2x) + (2A + 4B - 2C + 4D) \cos(2x) + (-4A + 2B - 4C + 4D) \sin(2x) \]

**Need to solve** \[ 4A - 2B = 0 \quad \Rightarrow \quad A = \frac{B}{2} \]

\[ 2A + 4B = -2 \Rightarrow B = \frac{-1}{2} \]

\[ -4A + 2B = 1 \quad \Rightarrow \quad B = \frac{1}{4} \]

\[ -4A + 2B = 1 \quad \Rightarrow \quad B = \frac{1}{4} \]

Now solve \[ 2A + 4B - 2C + 4D = 0 \]

\[ 4A + 2B - 4C - 4D = 0 \quad \Rightarrow \quad 6B = \frac{6}{10} \quad \Rightarrow \quad C = \frac{3}{10} \]

\[ C = \frac{3}{10} \quad \Rightarrow \quad D = \frac{3}{10} \]

**Thus, \[ y_p(x) = \frac{-1}{4} x \cos(2x) + \frac{1}{10} x \sin(2x) + \frac{3}{100} \cos(2x) + \frac{3}{100} \sin(2x) \]**

\[ y_p(x) = A x^2 + B x + C \quad \Rightarrow \quad y_p''(x) + 2y_p'(x) + 2y_p(x) = 2A + 4Ax + 2Bx + 2C \]

Now solve \[ 2A - 1 \quad \Rightarrow \quad A = \frac{1}{2} \]

\[ 4A + 2B = 0 \quad \Rightarrow \quad B = -1 \quad \Rightarrow \quad y_p(x) = \frac{1}{2} x^2 - x + \frac{1}{2} \]

\[ C = -\frac{1}{2} \]

Thus, general solution is

\[ y(x) = \frac{-1}{2} x \cos(2x) + \frac{1}{10} x \sin(2x) + \frac{3}{100} \cos(2x) + \frac{3}{100} \sin(2x) + \frac{3}{100} x^2 - x + \frac{1}{2} \]

\[ + C_1 e^{-x} \cos(x) + C_2 e^{-x} \sin(x) \]
Time Management

- Common time management strategies are useful in STEM
  - Maintaining a planner, having a semester calendar, having an exam study schedule

- Time management on STEM exams is critical for success
  - STEM exams differ significantly from humanities exams because of the nature of the grading scheme
  - Many STEM exams are designed to not be fully completed by students, and the exams get curved
  - Important for students to know how much time they have for an exam, and to budget their time based on the exam
  - Struggling with a problem often causes student to “tunnel” in on that problem
    - Important to advise students to not get stuck for a long time solving one problem on the exam
Campus Resources

- Professor and GSI Office Hours are paramount resources for any student in a STEM course
  - Professor (sometimes with GSI help) writes exam problems, good to get their perspective on what is important to take from the course

- TBP and Cal Math Department are useful test prep campus resources

- Departmental Tutoring Centers useful (e.g. Economics)

- Engineering Student Services (ESS) has helpful resources for engineering students
  - Advising, academic support, information on degree requirements

- Student Learning Center has highly successful academic support for many STEM classes (e.g. Most lower division Math)
Communication Modes

- As with general tutorial support, STEM tutors facilitate competency with different modes of communication
  - Examples: in person, word processing, texting, email, virtual tutoring

- One important form of communication in STEM is discussing grading issues with professor or GSI
  - Regrade requests are sometimes a feature for exams in STEM courses
  - Importance of being tactful and treating faculty with respect

- Learning to communicate with virtual faculty is useful for online courses
Critical Thinking

- Critical thinking in STEM ensures that students answer the questions they are supposed to be addressing
  - Excess information is often a problem in STEM
  - Descriptive data may act as a red herring, critical thought allows one to sort through what is important and what does not matter for a given problem

- Checking answers for validity is a form of critical thought
  - E.g. If you are solving a problem about how fast a runner is racing around a track, an answer of 10-20 mph would be reasonable, but 1000 mph would not be
  - Understanding mistakes in STEM problems facilitates growth and development as a student and as a critical thinker