



Research Methods in Science in Engineering

Teaching

Slide 1

Lecture Outline

- Steps for course development
- General advice

Top Two Things to be an Effective Teacher

#1 – Care

Care about the students and the job you are doing to teach them.

#2 – Work Hard

Work hard to develop an effective course plan, create effective assignments, have effective discussions with students, and give effective feedback on their work.

Everything Else

Teaching style, teaching methods, etc., are all secondary compared to the above, yet when discussing education, we ignore them entirely.

Steps for Course Development

Step #1 – Identify a Subject

It is likely you are assigned a subject and will not get to choose.

If you can, choose the earliest subject for your first course and develop other courses in sequence.

Step #2 – Identify a Teaching Style

We tend to consider only the students when discussing effective teaching styles.

I think the natural talent and experience of the teacher is equally important to consider.

* Teachers should not use this as an excuse to stay stuck in their ways.

- Teacher-centered
- Learner-centered
- Content-focused
- Interactive/participative
- ...
- Lecture style
- Flipped classroom
- Gamification
- Project-based
- ...

Step #3 – Plan the Course

Layout and organize all of the topics you want to cover on a calendar or Gantt chart.

Layout and organize all of the assignments and exams the course will entail on the same calendar or Gantt chart.

Coordinate and synchronize the above two things over the entire duration of the course.

Build in some margin and some bonus topics to account for delays or being ahead of schedule.

Step #4 – Develop Course Material

Write a syllabus.
Be clear and blunt.

Write your course notes.
Personal notes? Available online? Videos?

Write your assignments and exams.
Be consistent with your notes. Make instructions clear.

Coordinate all of the above.
You will likely find yourself going back to add topics, reorganize order, change wording and notation, etc.

Step #5 – Teach the Course

Treat your lectures like presentations.

Practice and strive to be clear and concise.

Make students comfortable to ask questions and participate.

Be kind and approachable.

Grade assignments promptly and provide meaningful feedback.

Get ready to adapt, improvise, and overcome!

Make the topics interesting.

Incorporate your research, experience, recent breakthroughs, etc.

General Advice

Assignments

- Make assignments as consistent with notation, wording and formatting of the course notes and lectures as possible.
- Make the assignments fun and meaningful.
- Do your best to gauge difficulty and time to complete assignments. Be reasonable.
- Create solutions along with the assignments to help catch mistakes and identify missing information.

Example of a “Fun” Assignment

Problem #3: Prevent the Apocalypse!

A long time ago, Seth, the Egyptian God of disorder and violence, murdered Osiris to become King of Egypt. Seven years later, Horus, son of Osiris, claimed the throne and defeated Seth in a vicious battle. Today, Seth has returned to earth for revenge and plans to destroy the world in an apocalyptic nightmare. He is hiding somewhere in Egypt. British intelligence detected an electromagnetic signal emanating from an ancient Egyptian shabti stored in the British Museum in London. The shabti was made in the image of the Egyptian God Ash, a known ally and supporter of Seth. From this signal, intelligence officers deciphered a MATLAB function $y = \text{ash}(x)$. It is believed that the roots of this function encode the GPS coordinates of the pyramid in Egypt where Seth is hiding. To stop Seth and prevent this disaster, help from Horus is needed, but Horus is currently trapped in Duat, frozen in a golden statue. The area where Horus is kept is sealed by two magic locks on an iron gate. Setting the two dials to the correct two numbers will open the lock and release Horus from his imprisonment. The wrong numbers will destroy the statue and Horus inside forever. It is believed that the correct digits for the locks are the orders of the roots: single (1), double (2), triple (3) or quadruple (4).



For this homework, download the mysterious $y = \text{ash}(x)$ function from the course website. Determine all roots to at least eight digits of precision in order to retrieve the GPS coordinates (units of degrees, i.e. *DD.DDDDDDD*) accurate enough to identify the correct pyramid. Enter these coordinates in Google Maps to locate and identify the specific pyramid containing Seth. Further, determine whether the roots are single, double, triple or quadruple to come up with the two-digit code that will release Horus, allowing him to seal Seth inside of the pyramid for the rest of time. Beware of the $\text{ash}()$ function! It is cursed and is rumored to produce odd behavior on modern computers. Even worse, calculation time depends on the mood of the Gods, so each value of y evaluated by $\text{ash}(x)$ can take a long time to evaluate. The fate of the world is in your hands!

In this problem, you must provide:

1. A table listing all of the roots, the method you used to find the root, the initial conditions for the method, the root to as many digits as necessary to identify the correct pyramid where Seth is hiding, and the number of iterations.
2. A professional plot of the $\text{ash}()$ function that identifies the roots, reports the roots to all digits that were retrieved, and indicates the roots as single, double, triple, or quadruple.
3. A short discussion to justify how you identified the roots as single, double, triple, or quadruple.
4. The GPS coordinates and name of the pyramid where Seth is hiding.
5. The two-digit code that will release Horus from his imprisonment.
6. Show all work and steps you used to solve this problem.

Hint: Get started on this problem early! Use the best algorithm in order to minimize iterations and computation time. Be careful!

Course Website

Creating and maintaining a course website is a lot extra work, but is tremendously helpful to the students.

Consider posting assignments, notes, videos, links to other learning materials and resources.

Consider tools other than Blackboard.

While Blackboard is an awesome tool, it requires a sign in, is only available to students during the semester, is only available to enrolled students, and goes down frequently during the semester.

Be Humble and Be Real

You do not have to know everything.

Do not fake it. Be honest if you are guessing.

You will lose the students if you act like a fraud.

Just be willing to dig to find the answers.

Make Instructions EXTRA Clear

When creating assignments or writing questions on an exam...

- Make instructions very clear and blunt.
- If done correctly, you will feel like you are giving them too much of the answer.

Be Fair and Consistent in Grading

Grade all assignments in one sitting. At a minimum, grade the same problem for all students in one sitting.

It is very easy to penalize different students differently for the exact same mistake. This is amplified when grading at different times.

Ignore the name of the student when grading.

Consider a simplified grading scheme that makes it easier to be fair and consistent.

Grading and Feedback

Do NOT just check a box if an assignment is done or not.
This does not encourage students to do well.

Grade every assignment and provide feedback.
If a student knows you are looking and caring, they will try harder and learn more effectively.

Good But Unethical Advice?

Be a very difficult professor during the first few weeks.

Be yourself for the rest of the semester.

The weaker students will drop the class and not give you bad reviews in the end.

The students that remain will primarily only remember the nice you and give good reviews.

Do Not Work Harder for a Student Than They Work for Themselves

Despite your dreams, you cannot rescue or turn-around every student who is falling behind.

In fact, turning a student around is much more the exception than the rule.

Such students require a huge amount of energy and attention.

This energy and attention is not going to the students who are working, trying hard, and perhaps more deserving of your attention.

When Overwhelmed, Simplify Grading

Students will try harder in a class if they think the professor is paying close attention.

Feedback on homework critical to conveying that you are paying attention to them and care about them.

We occasionally find ourselves overwhelmed and cannot devote that level of attention.

Use a simplified strategy that makes grading fast but gives the illusion of paying close attention.