# **Teaching Applied Calculus**

# Common mistakes and pitfalls to avoid

-overestimating or (more rarely) underestimating the level of the course or students;

-falling behind or (more rarely) going faster than the schedule;

-managing class time badly;

-being insufficiently prepared;

-not structuring the class meetings as explained in the next section;

- -using examples worked out in LON-CAPA; using abstract examples instead of concrete ones that allow computations and "pictures" at the same time;
- not dealing with discipline problems or dealing with them poorly;
- -not involving students during class;

-not following procedures when having to cancel an office hour;

-writing quizzes that do not test the material fairly or grading in an unfair way.

-not proctoring exams carefully;

*-not meeting deadlines* (e.g., for turning in grades); not responding to requests for information in a timely fashion; *-not sticking with the course policies; not following the guidelines for assigning final grades.* 

# Structure your class meetings well

All courses use the LON-CAPA online homework and course-content system--the system will be explained to you at the course organizational meeting. It is our experience that students like and even prefer to do their HW online if the instructor is supportive of the system. Please do not criticize the online homework system in front of your students. Instead, discuss your concerns about the system with your course coordinator. You should familiarize yourself with the system used in your course so that routine questions asked in class can quickly be disposed of.

The course coordinators will explain how many quizzes to give each week. All instructors write and grade the quizzes. All midterm and final exams are machine-graded and written by the course coordinator. You may be asked to contribute to the exam writing process by submitting exam problems.

High school Algebra is a pre-requisite for all these courses. However, expect to spend a fair amount explaining Algebra steps and having to finish the algebraic manipulations that lead to the final answer. Use feedback early on to get a good feeling on your classes comfort level with Algebra.

#### Main goals of a class meeting

- (1) return graded work promptly;
- (2) explain new material;
- (3) reinforce the topics covered earlier in the course;
- (4) give and receive feedback on how well the material has been understood and learned;
- (5) get rid of misconceptions; motivate and encourage;
- (6) clarify what is expected from students on the exams.

In MA 16010 you may also sometimes have to answer homework problems. In MA 16020 you typically do not answer homework problems.

# Parts of a class meeting

- (0) Get ready for class to start
  - get the class ready: erase the board; turn on the lights, write announcements, etc.;
  - put a transparency with the quiz's solution on the overhead (if applicable);
  - write the quiz average and range of scores on the overhead or on the board;
  - if using the overhead, make sure the image is sufficiently large and focused; dim the lights do not turn them completely off, especially if you are also using the board at the same time;

#### (1) Return quizzes and go over a quiz (if applicable)

- put new and old papers together in one alphabetical stack and return papers personally, preferably before class starts; (letting papers circulate is time-consuming, invites discipline problems and is a violation of privacy);
- point out the quiz average and the range of scores;
- do not ask which quiz problems they want you to explain; you know better than they do what the class needs;
- give feedback about common mistakes on the quiz; do not go over the quiz in detail especially if it went well; showing the quiz solutions on a transparency improves efficiency;
- do not involve students when going over the quiz: it is rarely constructive; you know best what needs to be said.

#### (2) Explain the new material

- see later section on "preparing a class meeting";
- never use examples worked out in Loncapa; always use concrete (not abstract) examples so you can "compute" the new concept (for example, the derivative) at the same time as you explain it on its graph;
- involve students; get regularly (after key steps) feedback on whether they are following;
- monitor your time carefully leave sufficient time for the guiz.

#### (3) Give a quiz (if applicable) - see course policies for frequency

- start and stop on time students cannot be expected to stay late;
- follow the course policies for the use calculators on quizzes; check early on that they use only allowed types of calculators so students are not faced finding out on exams that they are using one that is not allowed.

# Warning

# • It is crucial to follow the schedule: do not fall behind but, also, do not go faster !!

• If you miss a class (for whatever reason), see the course coordinator immediately to discuss how to make up the missed lesson (requiring students to attend an extra meeting is not an option) and the impact on the on-line HW deadline.

# Feedback, feedback and more feedback

Feedback is the only tool available to gauge whether the level and pace are appropriate for the students. The following two exercises allow you to judge whether or not you have enough and reliable feedback.

- (1) After teaching the new material, try to estimate the number of students that you think understood each type of example covered. If you find it hard to do, you did not have enough feedback while teaching.
- (2) If at the next meeting you are surprised by the popularity (or lack thereof) of a type of problem, you did not have enough (reliable) feedback while teaching the new material.

# Prepare well before going to class

# Preparing to go over a quiz

Write the solution, the average and the range of scores on a transparency.

# Preparing to cover the new material

- · Look at the HW assigned on the new material and check which parts of the section(s) are relevant to the assigned problems. Do not cover material not covered by HW problems. If available, look at the instructor tip sheet.
- Cover the material as much as possible via concrete examples. Avoid using "abstract" examples and giving long "theoretical" explanations but stress formulas they need to know and how to do problems (e.g., teach them what the derivative of a function is and how to find it on a concrete example such as  $f(x) = x^2$ ; do this both graphically and algebraically at the same time and stress the steps in an algorithmic way. This is better than using a graph without a concrete function attached to it).
- Choose as examples problems similar to assigned homework problems. Never use examples worked out in Loncapa.
- Use relatively short examples so you can do more of them and so students do not lose track of what you are doing.
- Plan before going to class how and where to involve students. Involve them as much as possible.
- Plan where to get feedback on whether they are following. Feedback is the only tool to determine an appropriate pace and level - see previous section to know if you have enough and reliable feedback.
- · Estimate how long it will take you to do each example with and without involving the students.
- Check whether you can do everything in the amount of time you have (about 25 min. see earlier). If not, decide what vou can drop or choose easier examples, etc.
- Using a two column system, especially in the beginning, might be helpful see further.
- · Use the same notation and terminology as Loncapa. Draw pictures whenever relevant.
- Plan how you will use the blackboard. Plan to save space for important formulas, etc.
- Consider introducing "objectives" by picking a problem similar to one of the hardest assigned ones and telling them at the start of class that by the end they will (should) be able to solve it. If there is time, end the class with them solving it on their own to see whether you met your objective.

#### Example of a two column preparation

#### Comment column

#### **Problem & solution column**

Estimated time :	#9 Find the absolute max. and min. of $f(x) = x + \frac{1}{x}$ on $\frac{1}{2} \le x \le 3$
with questions : 6-8 min.;. without : 4 min	Solution :
Domain of f? Do we worry about $x = 0$ ?	domain of f: $[\frac{1}{2}, 3]$ ; Note x = 0 is not in the domain
Ask the class what to do and why $\rightarrow$	<u>Step 1</u> : find the first derivative of f : $\frac{df}{dx}(x) = 1 - \frac{1}{x^2}$

 $x^2$ 

Next??  $\rightarrow$ 

<u>Step 2</u>: find the zeroes of  $\frac{df}{dx}$  (= critical points)

 $\frac{df}{dx} = 0$ ,  $1 - \frac{1}{x^2} = \frac{x^2 - 1}{x^2} = \frac{(x-1)(x+1)}{x^2} = 0$ Thus  $\frac{df}{dx} = 0$ , x = 1 and x = -1

-1 is not in the domain; 1 is. So, x = 1 is a critical point.

Should we consider both?

What now?? Feedback re endpts.!!

Step 3: evaluate f at the critical points and endpoints  

$$f(1) = 2$$
;  $f(\frac{1}{2}) = \frac{5}{2}$ ;  $f(3) = \frac{10}{3}$   
Conclusion:  $\frac{10}{3} = \max$ ;  $2 = \min$ .

#### **Preparing a quiz**

- Look at the material you want to test and decide what is most important. Do not plan to test everything.
- · Choose problems similar to an assigned HW one or modify an assigned one.
- Do the problems and time yourself: it should take you at most 2-3 min. for a 10 min. quiz.
- Write a flexible quiz: have an extra problem ready in case there is more time; have a shorter problem ready to substitute for a longer one if pressed by time.
- Write the quiz on a transparency, especially in case of word problems.
- Give closed-notes quizzes and have the students work alone. Do not help them or give hints. Students need the feedback on how well they can do in an "exam-like" situation. Cooperative quizzes do not give them that feedback and are not allowed in these courses.

#### Preparing the students for the next class meeting

- Look ahead to what will be covered in the next class meeting. If it uses prerequisites or techniques students have not used recently, tell them what to review.
- If need be, choose 1-2 problems on those prerequisites for them to work on at home before the next class meeting. You may want to use one of them as a "warm-ups" the next time - see next section.

# Warning

- It is not uncommon that in these course there are two class meetings scheduled for a topic. The topics introduced on "numerical" problems in the first meeting and the second meeting is word problems on the same topic. So, there is "nothing new to do" on the second day. *These students need to work on* (and not just see you do) *many word problems*. Use that second day constructively!
- One cannot map out exactly how a class meeting will go: sometimes there are many questions, sometimes few. Be prepared for various eventualities: write on the front page of your preparation an overview of what you will do in class and how much time each item will take. This together with monitoring regularly the time while you teach, will help you decide better on the spur of the moment which example(s) to drop - it should not automatically be the last one(s).

#### Involve students throughout the class period (except when going over the quiz)

# Why involving students during class?

- to give and receive feedback;
- · to have opportunities to detect common mistakes and correct them;
- to find the right level and pace and, to some extent, to tailor the course to the students' needs;
- to minimize discipline problems;
- to facilitate learning and provide encouragement.

#### How to involve students

#### A warm-up

- give a true-false or very short problem for them to work on while you return their papers;
- use it to get rid of misconceptions, to give and get feedback or to review a prerequisite;
- · do not do the problem in detail give the correct answer and a one-line explanation;
- use problems which can be done in 1 minute;
- this is not the same as introducing "objectives" which was mentioned in the previous section.

#### Call on specific students

- can be use as a way to learn student' names;
- useful in case of discipline problems see section on that;
  might be resented by students and might not always be constructive;
- useful to do if you know a person knows the answer and you need to get the class going;
- does not give a chance to other students to participate;
- might be the only method that works in a 7:30 class!

# Ask specific questions from the whole class

- no one in particular is put on the spot but often the same people answer or no one answers;
- giving the students a minute to think and asking them to raise their hand, might increase the number of people who can answer; it also provides feedback and cuts down on "the same people answering" (since you can call on someone else).

# Ask feedback questions: "Raise your hand if you think this is right"

- no one in particular is put on the spot but often the same people answer or no one answers;
- can be combined well with the previous kind if the same students always answer and can then be followed with the first kind to get more information or a correct answer.
- if at the end of a class you cannot gauge how well the students understood a type of example you taught, you did not get enough feedback while teaching it.

# Check frequently that the students are following

- make sure after key steps and not just at the end of a problem or example that the students are following;
- vary how you ask: "Are you with me on this?", "Is that OK so far?", etc.
- phrase the question so that responding (and not a lack of response) gets rewarded (i.e., "who wants me to explain this again?" vs. "is that clear?")

# Have a student do a problem on the board

- often no one or only those who can do the problem volunteer this may depress the other students;
- students often resent being sent to the board;
- have the student explain the solution and get the other students to ask questions if something might not be clear; try
  not to have to "do the problem all over again" that is very time consuming;
- · correct all mistakes including notational ones.

# Give the students a problem to work on while you go around and help

- give a simple, short problem similar to an example you did;
- it is a pleasant change from the "watch-and-answer" routine and gives feedback if you go around;
- if going around, give feedback when done (not necessarily when everyone is finished) such as "everyone knew how to start", "people got stuck on this step"; if not going around, ask for feedback;
- give the final answer even if you do not do the whole problem;
- to save time: do the above with a key step in an example instead of a whole problem; in that case do not go around but ask for feedback on who found what as answer.

# A "test yourself"

- write a problem and its answer (not its solution) and tell them to solve it within a certain amount of time on their own at home *with their notes closed*;
- this might lead to their involvement the next meeting when you ask for feedback, etc.;
- this can also be used as a way of stating a goal for that class meeting: "At the end of this meeting, we should be able to do the following type of problem ...";
- do not use this instead of weekly quizzes.

# Warning

- Combining some of the above methods is more effective (and less boring) than using just one.
- Involving students in class takes preparation and constant work on any instructor's part.
- Involving students can (but does not have to) be time consuming. Monitor your time carefully.

# • Feedback type questions are the only way to determine an appropriate level and pace.

# Deal early on and well with discipline problems

# What are discipline problems?

- Students coming late or leaving early.
- · Students talking to their neighbors.
- Students (usually just one or two) interrupting with irrelevant questions (to the extent of stopping the regular "flow" of the class and annoying a fair number of the other students).
- · Students running/controlling the class.
- Students pulling other students' hair (luckily, infrequently) or passing notes back and forth.

#### Why are they happening?

- The student has a need to impress you or the rest of the class.
- The student is at an age when he/she needs to challenge authority.
- The student feels insulted/humiliated that he/she has to take the course.
- The student does not want to come to class but has to take (frequent) quizzes.
- The student is new to campus, feels lonely, wants to make contact with his/her peers.
- The student is bored; he/she has seen it before. Or the opposite: the student is lost.
- The instructor is not dealing with the students' questions or difficulties.
- The instructor copies what is in Loncapa, is not well prepared, does not involve students, etc.
- The instructor does not give students opportunities to participate.
- The student has problems that have nothing to do with the instructor or the course.

# How to deal with discipline problems

- How to deal with a problem depends on why it is happening ask for advice before you lose the class.
- Avoid being confrontational.
- Talk to the student in private and stay calm. Be specific as to which behavior you want stopped.
- Appealing to the student's sense of fairness (towards the other students) is often helpful.

- Reversing roles (how would you feel if you were trying to learn but could not because ...?) also often works.
- · Avoid getting dragged into an argument or having the problem escalate.

# Warning

- A quiet class is not the same as a class without discipline problems.
- Monitor your class for developing problems and deal with problems early on.
- · Do not ignore problems: they will not go away; they will become worse.
- Do not try to explain to a student why you think he/she is behaving in a certain way.
- Do not expect the other students to deal with a problem: it is your job to do so.
- Get help early on if need be.

# Some rules and regulations

#### Students with disabilities

A handout is available at <u>http://www.math.purdue.edu/resources/ada</u>/. Read it close to the start of the semester. Do not assume your and your students' responsibilities are the same from course to course or from semester to semester.

# Communication

- Check your mailbox and e-mail (your @purdue.edu) regularly even on days you do not teach. If your @purdue.edu email address is not your primary email address, then make sure your @purdue.edu address forwards messages to your preferred email account.
- *Respond* promptly to any request of information within one business day. Mailboxes are <u>under</u> the names.
- You are the main source of information for your students. You must know the exam dates, the ground rules, etc.
- MATH 202 often has the answer to many questions or will be able to tell you whom to contact.
- Make sure that students joining your section late "receive" immediately the assignment sheet and ground rules.

# Employment periods, vacations and holidays, future parental leaves

- Employment starts on the Monday before classes start and end on the Tuesday of the week after finals week.
- Official university holidays on which classes do not meet are the *only vacation days* for TAs during the semester.
- TAs are entitled to some leaves of absence with full pay (for illness, jury duty, death in the family, etc.) Fill out business forms in a timely fashion.

# Absences due to illness, job interviews, conferences; canceling classes, etc.

- You do not have the authority to cancel a class meeting even in case of illness, emergency, etc.
- In case of illness or emergency, you are required to call the Main Office (4-1901) as early as possible. Clearly state what course you teach, at what time(s) and where. Also state what Lesson you planned to cover and when you expect to resume your duties. We will try to find someone to substitute for you.
- Leaving a voice-mail message is not sufficient. Follow such a message up with other calls till you reach a person. Inform that person also about the voice-mail message you left.
- In case of a non-emergency absence, you must find a suitable substitute, fill out and turn in a Substitution Form (available from the Main Office) at least 3 days in advance.

# Office hours (OH)

The common office hour schedule will be created automatically based on the schedule information you submit on the New TA survey or the Fall (or Spring) TA survey and will be published on or before the Tuesday of the first week of classes in Fall semester and on or before the Friday before classes start in Spring. Changes to the schedule require permission from Dr. Phil Mummert (pmummert@purdue.edu). Permission is only granted in extraordinary circumstances. On 10:00 am Friday of the first week of classes the schedule is finalized. If you absolutely have to make changes after the first week, you are required to obtain permission from Dominic Naughton. Permission will only be granted in rare cases.

- Holding office hours is an integral part of your duties: do not cancel or reschedule an office hour; be on time; stay for the whole duration of your office hour; act in a professional way. In the math help room be pro-active. Do not just sit and wait for students to approach you; do not read your e-mail, etc.
- If you have to cancel an office hour because of an illness or emergency, read the office hour absence policy under Office Hours at http://www.math.purdue.edu/resources/gta/
- Limited-term lecturers are expected to make themselves available to their own students before or after class. They may use MATH 845 to do so. Keys are available from K. Beranger in MATH 842.

#### **Course rosters**

See http://www.math.purdue.edu/resources/gta/ for instructions on how to download course rosters.

# Mandatory 4th week Initial Course Participation Report - see also http://www.math.purdue.edu/resources/gta/

Purdue requires all instructors to submit on-line via *myPurdue* an *Initial Course Participation Report* by the end of the 4th week even if all your students "participated" (= the default setting). Please wait until close to the end of the 4th week to do so. "Participation" can be verified by a student having a HW, quiz or exam score or being present at a roll call.

#### **Grief Attendance Policy for Students (= GAPS)**

Purdue's GAPS states how may days of excused work (undergraduate and graduate students) students are entitled to for the death of a family member. (This policy does not impact the number of paid leave days instructors have.) Refer to **http://www.purdue.edu/odos/services/griefabsencepolicyforstudents.php** when needed.

# Departmental policies and procedures; Informal Early Feedback; course evaluations, submitting final grades

A memo on *Policies and Procedures* is available at: <u>http://www.math.purdue.edu/resources/gta/</u> More information on the Informal Early Feedback, course evaluations, submission of final grades is also available at that side. *Noncompliance with departmental policies especially those related to submitting final grades may result in immediate or future termination of employment.* 

#### Tutoring

It is unethical and against departmental regulations to tutor for pay any student enrolled in any of the sections you teach. International students should check with ISS on the legality of being a tutor.

# Dating students and other possible conflicts

"Amorous" relations between instructors and their students are against Purdue policies. It is against departmental policies for you to date a student in the class you teach or to accept invitations to a social event from a student in the class you teach or to make an invitation to a social event to a student in the class. Please be aware that having roommates, close friends, family members, etc. as students might also cause professional conflicts or might be perceived as such by others. If this applies to you, please let me know as early as possible.