STAT 110 TF Things to Consider

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The Role of the TF

- For better or for worse, you are the main point of contact for students (at least in terms of face-time). In general, students will be more comfortable bonding and trusting their TFs.
    - Your students aren't just NPCs sitting in chairs. Don't treat them like NPCs!
    - Make an active effort to get to know your students and remember your students' names! The joy of teaching comes not only from discussing the course material, but also from the relationships you build with your students.
        - Ask for students' names when you call on them or when they go up to you with a question.
        - You can have some casual conversations in the few minutes before section starts, for those who arrive early.
- Many students may feel uncomfortable directly voicing their concerns to the Professor, but may feel very comfortable speaking up to you. The ball is in your court to forward the message to the Professor and advocate when appropriate. You are in a position of trust – *do not abuse this trust.*
- If there is sufficient trust between you and your students, they will be more empowered to reach out (potentially personally) when they need help and may be more vulnerable with you. *Do not abuse this trust*.
    - Treat your students with utmost respect and empathy, and do your best to *understand where they're coming from*. If they tell you they are worried about the class or struggling in any way, respond to them gently, patiently, and constructively. Downplaying, ignoring, or not following up with them on their concerns are examples of breaking this trust.
    - With that being said, make sure to enforce boundaries.
- One of the best ways to solidly learn material is to see the material *multiple times*, *in multiple different ways*.
    - What already exists:
        - Lectures already exist.
        - Lecture recordings already exist.
        - The textbook already exists.
        - Section notes will be readily available in .pdf form on Canvas.
    - What additional value / approaches can we bring to the material through section?
        - *Multiple different ways* can also mean "with multiple different emphases."
        - One potential option is to select a set of practice problems and work through them, emphasizing potential potholes, heuristics, ideas, etc.
        - Another potential option is picking 2-3 of the most challenging topics for that week and going on a deep-dive of those, going step-by-step.
        - Remember that there are two 75-minute lectures a week, and you only teach one 75-minute section.
        - Forming *connections* between seemingly unrelated parts of the course to reinforce understanding. Maybe designing practice problems that emphasize the nuances in certain concepts or groups of concepts.
        - Stripping away more of the jargon / presenting easier-to-visualize ways of thinking through a set of math equations.
        - We don't need a read-aloud of the textbook and/or your section notes.
        - Minimize arithmetic — you want to spotlight the concepts on a time limit
- The TF role is not just about helping explain the material and with problem-solving, it's also an opportunity to provide motivation and inspiration for why this material is worth learning. This is a role where you can give supportive general advice, and underscore the message that almost everyone (including the TFs when they were students) found the material challenging too, but that with enough practice and hard work it gets much easier and more intuitive :)

(NOT) The Role of the TF

- You are *not* expected to be a walking encyclopedia. You are certainly qualified and have been hand-picked to serve as a TF by Prof. Blitzstein. You belong.
- If you don't know the answer to a question, don't try to make something up or give a super fuzzy / nebulous answer. Just be honest.
    - "I really don't know how to answer this question, and I don't want to give you a half-baked answer. I'm more than happy to forward this question to the other TFs and Prof. Blitzstein and get back to you. Please send me an email following-up on this after section / OH so I don't forget."
- If you've realized you made a mistake during section / office hours that students may or may not have caught, *demonstrate integrity and send a correction Ed post or email.*
    - As a TF, you are in a position of trust. Your students will put full faith and confidence, for the most part, in what you say. Don't abuse that trust.
    - There is no shame in making a correction. You're just being a TF with integrity.
- You are *not* a 24/7 emergency hotline. Please make sure to clearly establish your boundaries – for your own mental health and well-being.
- While it is not your responsibility to develop / prosecute honor council cases, if you see any cases of suspected academic integrity issues, please report them to Prof. Blitzstein.
- If students ask for extensions, you can say that granting them (or not) is not within your authority as a TF. Ask them to reference the syllabus and, in especially extenuating circumstances, directly email Prof. Blitzstein.

Students' Differential Backgrounds

- STAT 110 has a very, very diverse student body – in all senses of the word "diverse." It's our job to create a welcoming & empowering environment for everyone.
    - Some students in your section may have represented their countries at the International Math Olympiad. Others may have gone to high schools where calculus was not offered.
    - With the rise of AI/ML/DS in all fields (STEM or not), it is not unlikely that you will have students from many non-STEM fields like Psychology, or Government, or even English who don't consider themselves strong at STEM. Remember, they belong. They're here to learn. You're here to help them learn.
    - Many students in STAT 110 may also be graduate students and/or people who are going back to school for the first time in decades. They might not feel comfortable with the math that they learned 20 years ago. They may also feel a little uncomfortable "having to learn from a 19 year old kid." Your job is to make your teaching environment as welcoming as possible.
    - When possible, try to avoid jargon / break down the jargon into visualizable + more manageable pieces.
    - In the same vein, try to avoid using slang before understanding your audience. Opaque slang can really isolate students from different cultures/generations.
- Working with students who are really struggling:
    - Inevitably, given the nature of the course and the diverse range of students who take STAT 110, there will be students who will truly struggle with the course, whether conceptually, from a grade standpoint, or workload-wise.
    - You can encourage these students to set up a 1-on-1 meeting with Joe, offer time during office hours to explain concepts carefully to them, and give them ideas for how they can reinforce concepts that might have been covered quickly during class. We are also

working on new ways to provide small-group / 1-on-1 support for students — details are TBD for now, but stay tuned.
    - Sometimes, the job of the TF is to be a sounding board and also emotional support for students who are struggling, but also remember that it is not your responsibility to carry a student through the course but rather to direct them towards resources and methods by which they can improve.
- "I cannot promise that all of you will get perfect scores on the midterm and final in only half the time allotted. What I *can promise* is that I will try my best to *meet you where you are*, and help you *maximize your individual growth and progress*."

Preparing for Section and Office Hours

- Time spent preparing for section and hours will certainly vary between new TFs and veteran TFs who have seen the material multiple times over the years.
    - *During their first semester TFing*, SW + CH spent roughly 1.5-3 hours each week to prepare section notes and divide up who's presenting which portions.
        - One strategy is to go through the textbook readings for that week, with some padding before and after for good measure, and make sure that all of the core definitions, theorems, corollaries, biohazards, etc. are accounted for in the section notes.
    - For the first few sections of that first semester, SW devoted roughly another 1-2 hours towards individually finalizing delivery practices and annotating the handout with additional points of emphasis. This time would generally decrease as the semester progressed and he became more comfortable.
        - One helpful technique is to mentally break down concepts into "simple English" without any terminology / fanciness.
        - Another strategy is to prepare toy examples with small numbers that students can almost-instantly brute-force the correct answer to (within seconds) as sanity-checks + build intuition. Prof. Blitzstein introduced this method to SW as "SNOTE": *smallest, non-trivial example.*
        - It is also helpful to highlight *category errors*, since it's important for students to be able to recognize and diagnose whether their answer or approach is a category error. For example, when one calculates a probability that should have been ⅓ and gets ¼, it may be hard to detect the error, but one gets -¼, one should immediately realize it's a category error and then go back and check work.
        - CH spent 1-2 hours per week individually reading the textbook to find biohazards, edge cases, and especially insightful examples to emphasize, and wrote them down in her copy of the section notes. This time commitment remained fairly consistent throughout that first semester, since CH also used this time to solidify her knowledge of the material.
- Prepping section handouts:
    - Using past TFs' .tex files as a starting point is definitely a good idea.
    - Always reference Prof. Blitzstein's lectures for the week of interest and make sure your section materials are synchronized.
        - Note that section notes templates from previous years may be following a slightly different schedule.
        - If you don't have enough time to watch / skim the entire lectures, you can also reference Prof. Blitzstein's lecture slides to get an idea of what was covered and to what extent.

        - Make sure to keep your notation / language consistent with lectures / the textbook. *Many students are having a challenging enough time already trying to understand the concepts – no need to make them do on-the-fly mental translation between notational conventions.*
    - Think about the parts of the material that challenged you the most as a student. Make sure to make note of these parts in your own section notes.
        - *Without giving away the problem*, it is also a good idea to consult the HW assignment for that week and see if there are any problem-solving techniques / ideas that weren't covered in lecture, but are critical for some portions of the HW.
    - Each TF / section has their own preferred split of concept review vs. practice problems – gauge your section's preferences over time + via feedback form.
    - Use italics, bold, all-caps, color, etc. to selectively-emphasize specific concepts.
    - SW + CH will generally print some (limited) copies of their section handout each week because some students still prefer to write with pen and paper, especially for problem-solving and/or want to use their iPad to keep the textbook open.
    - Remember, not everything in your section handout has to be covered in your oral delivery. Nor does everything in your oral delivery have to be written in your section handout.
    - If you include practice problems, make sure to leave sufficient white space beneath each problem so that students don't feel cramped when writing.
    - Try to upload solutions to any practice problems in your section handout within a few days after section.
- Prepping for office hours (roughly ~1 hour):
    - Make sure to walk yourself through each problem in the HW solutions and annotate which parts you anticipate will be especially challenging / mind-twisting for students. Try to study the homework in enough detail in advance so that you won't have to refer to the solutions too much *during* office hours.
        - Students might otherwise get the feeling that the TF is referring to a secret script—this might, in turn, give the discouraging impression that the homework is so difficult that the TFs would not be able to do it without just reading the solutions :(
    - As an alternative to directly feeding answers, if there's a particular twist in a problem that is critical towards finishing the solution, you can prepare 1-2 toy examples that are very closely-related to the HW problem itself, but not quite identical to the specific variant of the trick in the problem.
    - If there are any textbook theorems that are critical for a solution, be a good citizen and have the page in the textbook annotated in your reference solutions.
    - Sometimes, it may be helpful to have a print copy of your section handout available as well, just for quick reference.

Encouraging Inclusion and Active Participation in Section

- Section is **optional.** What this means is that the students who go to your section are likely in one or more of the following groups: 1) students who really want to reinforce their learning; 2) students who feel especially nervous about the material and need some extra help; 3) students who need the material explained a different way from lecture / just reading the section notes offline. *In short, these are students who are taking active ownership of their learning and deeply care about their learning.* Know your audience.
- SW + CH generally do not require raising hands and allow students to just directly call out questions / answers. Adapt to your section. Everyone is different.
- Intentional phrasing + establishing norms:
    - "There are no stupid questions in this section. The only potentially stupid questions are the ones that I ask."
    - "*What* questions do *we* have?" (good) vs. "*Do you* have any questions?" (nah)
    - "The stuff we're covering today is challenging for a lot, a lot of people, *including myself.* If you have a question, the person behind you and the person to your left likely have the *exact same question*. You're doing a public service *by stepping up and being brave.*"
- Remember when you were in their shoes
    - Point out concepts that you personally struggled with
        - This may help emphasize/normalize the fact that the content is challenging
        - Your struggles mean that you have deeper insight into how to understand that concept. You can use the explanations that worked for you.
    - Never call anything simple, easy, trivial, etc.
    - Expect practice problems to take much longer than they took you
- People pay more attention to things that may be directly useful to their work / interests. This sounds like common sense, but it's sometimes unclear how to leverage that to make your section more effective.
    - Get to know the people in your section. Are they interested in biology, psychology, ML, or quant finance, etc.?
    - Draw direct connections (when appropriate) on *why* the theoretical stuff we're covering today might be useful in the future. For example, for the public health folks, suppose you want to make a prediction about the number of Dengue fever cases next month.
        - "A Poisson distribution might make sense because … and, most importantly, *people actually use this in practice – Poisson regression, instead of just fitting a line through the data points because … (see STAT 139 + 244)*."
- Coffee Questions:
    - Sometimes, to encourage participation and build confidence, two of the authors will use "coffee questions," or slightly-pathological (ish) questions written by one of the authors of this document that have one or two twists that *serve an educational purpose* of drawing out some of the trickier nuances in a concept.
    - Sometimes, we will also use questions adapted from previous quant finance interviews / prep resources to build confidence.
        - "I solved a Jane Street quant interview question!" can build quite a bit more confidence than you might expect.
    - The idea is to promote a little bit of *healthy* competition and encourage students to participate more, instead of waiting for the TF to explain the problem.

        - "The first two people to get this question right will get coffee of their choice from Capital One Cafe[1] hand-delivered to their seat during section next week." Believe me, it will get rowdy.
    - Make sure to keep it as healthy competition. Make it clear that this difficulty of question will *not be likely to appear on the HW or exams.*
    - Make sure to debrief the question afterwards / post a follow-up on Ed.
    - This is a good way of catering to all comfort levels in your section. Sometimes, for students who are solid in the material overall, but just want to brush up on a few specific pieces during section, we put up a coffee question at the start of section. A lot of it comes down to balance – balancing focus, encouragement, fun, and learning objectives, as well as *morale.*
        - Coffee questions are *certainly not mandatory*, and you should only try out these sorts of "add-ons" if you believe it is best for the specific people in your section. Always remember to adapt to your students.
        - Check your feedback forms to always gauge what's working and what's not working (see "Learning to Learn, and Learning to Teach").
        - If folks in your section are returning feedback saying that they don't like the extra competitiveness, then maybe pause the coffee questions.

<u>Teaching in Action</u>

- <u>Multiple Perspectives</u>: Much of probability can be unintuitive at first encounter, so it's helpful to approach a challenging problem with multiple approaches, or even the same approach but worded slightly differently. Here are two examples of how this can be done:
    - Example 1: Monty Hall, what is P(win if we do the "switch" strategy)?
        - Approach 1 (mathematical approach): formally write out LOTP, conditioning on which door the car is behind
        - Approach 2 (pure intuition): if the contestant employs the "switch" strategy, the contestant only loses if the car is behind the door they were initially at (before they switched), which has probability 1/3
    - Example 2: If a stick is broken at random into three pieces, what is the probability that the pieces can form a triangle?
        - Approach 1 (more mathematical/graphical approach): say the three pieces have length x, y, and 1 - x - y. The triangle formed by the x-axis, y-axis, and the line x + y = 1 corresponds to the sample space. We have a triangle if the following triangle inequality equations are satisfied:
            - $x + y > 1 - x - y \Rightarrow x + y > \frac{1}{2}$
            - $x + (1 - x - y) > y \Rightarrow y < \frac{1}{2}$
            - $y + (1 - x - y) > x \Rightarrow x < \frac{1}{2}$
            - We can represent these inequalities graphically, and get a "solution" region whose area is ¼ the area of the triangle.
            - $\Rightarrow$ probability of triangle = ¼
        - Approach 2 (more intuition): a triangle is possible iff no part > ½ (by triangle inequality)

[1] Not sponsored by Capital One, Peet's Coffee, nor any of their affiliates. But, having a Capital One credit card does give you 50% off any hand-made drink at any Capital One Cafe, every single day of the year. See 24 John F. Kennedy St, Cambridge, MA 02138 for details.

    - With probability ½ both breakpoints are on the same side of the midpoint. (no triangle)
    - Conditional on the above not happening (i.e. breakpoints a < b are on different sides of the midpoint), then with probability ½, the breakpoint a is "further left" in its left half than b is in its right half. (no triangle, unconditional probability ¼).
    - ⇒ probability of triangle = ¼
- Scaffolding (example with counting, distinguishability, accounting for overcounting):
    1. How many ways can we divide 3 people into 3 teams (each containing one person), with team names A, B, and C?
    2. How many ways can we divide 3 people into 3 teams (each containing one person)? There is no order or distinguishability between the teams, now that team names have disappeared.
    3. How many ways can we divide 4 people into 3 teams of sizes 2, 1, 1, with team names A, B1, and B2?
    4. How many ways can we divide 4 people into 3 teams of sizes 2, 1, 1?
    5. How many ways can we divide 5 people into 2 teams of sizes 3 and 2, with team names A and B?
    6. How many ways can we divide 5 people into 2 teams of sizes 3 and 2?
    7. How many ways can we divide 12 people into 3 teams of sizes 2, 5, 5, with team names A, B1, and B2?
    8. How many ways can we divide 12 people into 3 teams of sizes 2, 5, 5?
    9. Finale 1: How many ways can we divide up 17 people into 4 teams of sizes 2, 5, 5, 5?
    10. Finale 2: How many ways can we divide 25 people into 8 teams of 3, 2, 2, 2, 4, 4, 4, 4?
- Focusing on Purpose and When-To-Use: One of the challenges of Stat 110 is to see a problem and quickly know *which* tool (or *combination* of tools) from the class to apply towards the problem. Towards that end, it is helpful for students to understand the purpose and usefulness of each tool, and when (in what types of problems and what scenarios) to use which tool(s).
    - Examples: inclusion-exclusion, LOTUS, indicators/linearity/fundamental bridge, famous distributions, conjugacies, special stories (gambler's ruin, chicken-egg, bank post-office)
- Presence and presentation:
    - When writing on the blackboard, don't squeak the chalk (breaking the chalk in half is an easy way to prevent squeaking).
    - Try to face the students as much as possible, rather than "talking to the board" due to spending so much time facing the board while writing.

Office Hours and (Not) Answer-Feeding

- For better or for worse, people feel that their grades matter. And we think it is valid for folks to feel that, especially when considering aspirations for graduate / professional school, getting a job, and how the people around them perceive them. This is reality, for better or for worse. And that reality won't change overnight.
    - "If you folks help me out, I'm confident that we can at least get through these problems. But you guys have to lead the discussion." (see 3 bullet points down).
- That being said, while we can't change reality overnight, we can encourage students to focus at least slightly more on the learning, and less so on the grades.
    - In the long run, an individual HW assignment is not high-stakes. But an exam is relatively much higher stakes.
    - In the process of facilitating discussion during office hours, you can emphasize certain concepts that appear in a given problem, and the trippy nuances that could arise on a *potential test problem*.
- If office hours are not crowded, individualized / small-group help is often ideal.
    - Create a queue using Google Forms or Google Sheets and *encourage small groups* so that students can help each other + also get priority help on the queue. It also makes your work more efficient.
        - Sometimes, students will try to overwrite each other's names on the queue on Google Sheets (intentionally + unintentionally).
        - One good idea is to use Google Forms as the input source, and give "View Only" access to the resultant spreadsheet so people can still track their place on the queue without overwriting it.
        - Avoid rushing at all costs. A growing queue can be intimidating, but we want students to know that their questions are worth our time. Additionally, if students see that you will answer each question thoroughly, they may be incentivized to work with other students.
    - "Help me help you. What have you tried so far? And where is the brick wall?"
    - **Encouragement is very, very important!** Validate intermediate ideas / considerations that folks have, even if the overall sketch of the solution may have a roadblock or two.
        - Build up from those intermediate ideas. Try to use as much of the student's contribution as possible, instead of saying "great idea, but we're going to try something else."
    - Focus not on building up just the correct homework answers, but more so students' correct conceptual understanding of each problem's ideas.
        - For example, students might go up to you asking to check if their final numerical answers are correct. It is not your job to tell them if their final answer is correct, nor to check line-by-line long algebraic derivations.
            - You can ask students to compare the numerical answers with someone else in the class.
            - You can help students understand the concepts and strategies behind the problem, help work through similar examples, and help answer questions about whether specific steps or ideas make sense, but remember, you're not the debugger or the checker of the final answer.
            - Be constructive. If a student's approach is incorrect, don't just tell them "you should be doing/getting something different"—patiently ask them, rather, for how they got to their answer, and guide them towards *conceptually* and/or *intuitively* where they went wrong.

        - Not *all* roads lead to Rome, but many do. Some are more scenic than others.
    - If they're really close, of course, it is certainly appropriate to let them know how much they're off by – sometimes it's a slight calculation error, and other times it's because they missed a case or two. Be flexible and kind, but still adhere to your principles and role as a member of course staff.
- One potential approach for especially-crowded office hours:
    - Don't directly feed the answers – but encourage students to lead the discussion of a HW problem. If students feel uncomfortable going up to the front of the classroom in front of 80+ people, you can offer to be the scribe.
    - Key rule: "I'm happy to help scribe, but **I will not write anything on the whiteboard unless one of you tells me an idea or step.** I am also happy to discuss whether your step is reasonable / practical / will not condemn you to do an extra 2 hours of grueling, sad casework."
    - With the above policy, there may be some awkward silences while you wait for a student to take the lead, but 9 times out of 10, someone will step up.
        - Awkward silences are fine. People will quickly realize that unless someone speaks up and participates, there will be no progress.
        - Some students may feel not-so-confident speaking up, but still gather up enough courage to take point on a problem (because they want it done). Encourage them! Hype them up! If they make a good intermediate point / bring up a relevant reservation, affirm them!
        - Sometimes, these students will really hit their stride, and the more you ask follow-up questions / affirm their step-by-step progress, they will build up confidence and might even finish the whole problem on the spot …
            - You have to be careful: some students may feel intimidated by a back-and-forth with their TF, even if they are making great progress. Others love the empowerment. Tailor to the student.
        - … BUT, you *do not want the rest of your students to just sit there* and copy down the stuff on the whiteboard.
            - You can choose to write only broad sketches on the whiteboard and leave out some details (which you may choose to *say* out loud, of course) for students to think about more.
            - If a student is being awesome and finished 2 out of 5 steps of a problem, ask for another volunteer to step up to spread the love.

Learning to Learn, and Learning to Teach

- Let's face it — the first time you teach a section will almost-surely not be your best teaching. That's just reality.
- Have a feedback form, potentially with the option to go anonymous, so that students (the people you are working for, effectively) can tell you 1) what's going great; 2) what's going not-so-great (e.g., speed, style, format); 3) and any ideas on how to improve.
    - However, *only* having an anonymous option is also *not recommended* because sometimes you *do want to* follow-up individually with students on specific questions and/or concerns.
    - Food incentives are oftentimes great for increasing survey participation[2] 🙂.
- Every section is different. Maybe the students in your section are really outgoing and want to lead problem solving. Maybe the students in your section prefer a little more guidance. Get to know your section.
    - Sometimes students want a little more direct instruction, other times they might want more practice problems + walkthroughs. Know your section.
    - Sometimes you will receive a cluster of survey responses indicating that they didn't really understand your coverage of joint PDFs. Feel free to invest maybe 10-15 minutes in the next section to reinforce it.
    - Sometimes students may or may not want you to cover a little more material and give them a first-pass preview of the lecture material for next week.

A Cautionary Note on the Q Guide

- The number of reviews you get on the Q Guide and/or the content of said reviews ***are not*** unbiased estimators of your impact and quality as a TF. It may be tempting to conflate "optimizing for the maximum Q Guide score" as equivalent to "optimizing to become the best TF possible" (with purely noble intentions), but this is ***very dangerous*** for both you and your students.
    - Sometimes, the right thing to do as a TF is not necessarily the thing that would make some students "happiest" in the short run.
    - There is no shame at all to taking a "hit"on the Q Guide for enforcing course policy and values, and maybe incurring some students' retaliation.
    - A TF who serves 5-10 students a week with lots of personalized attention + instruction is not inherently "less valuable" or "less impactful" than a TF who has triple-digit section and office hours attendance.
- Long story short, there is no reason or value to compare yourself with other TFs.
- Of course, if you do receive feedback that you believe is meaningful and relevant, there is certainly no shame at all to adjusting your teaching during the semester to become a better TF.

[2] 65 John F. Kennedy St, Cambridge, MA 02138.

Final Remarks

With everything said, this is *definitely not an exhaustive guide* to TFing. The four of us are also finding plenty of ways to improve our own teaching every day. We simply hope that the ideas we shared give you some things to think about as you go on to lead your own sections and hold your own office hours. If you have any questions or concerns, we'll be here.

TFing is a privilege and an honor. You've got this. Go make a difference.

Godspeed.

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