

In this class, we will be spending a lot of time tackling hard concepts and developing deep understanding. One of the best ways to refine your thinking and to get a boost when you're stuck is to explain your reasoning. In this class, we will use an exercise called Peer-Assisted Reflection (PAR) to give you practice at analysing your own thoughts as well as understanding how others think. Research has shown as much as a 20% improvement in student learning by using PAR. We're including PAR in this course because we want to provide you with the best learning techniques we know of!

### 1. PAR Basics

- (a) Roughly one homework problem a week will be designated as a PAR problem. You work on this problem alone or with peers and write up your solution. You will then complete the self-reflection sheet for that problem.
- (b) In discussion section, you will sit in a random seat. This is so you get exposure to a large sample of your peers' work, not just your friends!
- (c) You will exchange write-ups with your neighbor, read it carefully, and spend some time providing them written feedback. It is important you provide written feedback before you start talking with your partner. When you are reading another student's work, you are focusing on what they've written and how they expressed their thoughts, not the problem itself. (You've already spend a lot of time thinking about the problem!)
- (d) Conference with your neighbor and explain your feedback in words. Providing feedback is not an option. Even the best solutions can be made better. Even if you did not complete the problem, you can still engage in written feedback and conferencing.
- (e) At home, you revise your PAR question and turn in your PAR work the next day of class. Your PAR work includes (i) your draft with comments, (ii) your self-reflection, and (iii) a *typed* final writeup of your PAR question.

### 2. Frequently Asked Questions

- (a) *What if I miss a PAR day? Can I still get credit?* Yes. You can do the peer conference with one of your classmates outside of class and turn the PAR problem in as normal.
- (b) *If I didn't solve a PAR problem, do I still participate?* Yes! Even if you haven't figured out the problem, you can give valuable feedback and pick up some new ideas from your peers.

## Being a Critical Friend

Peer-Assisted Reflection (PAR) will help you improve your communication skills and understanding of this math course. Writing for someone who does not already understand your problem is a skill that requires practice. We will improve our skills by acting as "critical friends" to each other. Critical friends take the time to fully understand each other's work, finding the flaws and weaknesses so that they can be improved. Critical friends don't just say "everything looks good," because it provides no room for growth.

### Reading Peer's Solutions

- Try to understand the solution based only on what is written (without thinking of your own solution). Note any gaps in logic you have to fill in yourself. Tell your partner—these need to be revised.
- Was the solution justified? What evidence would you need to be sure the solution is correct?
- Note any calculation or procedural errors you find. Don't just gloss over calculations, but work them out in your head to see if your partner's work makes sense.

- After you've fully considered what your partner wrote, compare their solution to your own. Did you get the same result? If you used different approaches, were they consistent or did your solutions contradict one another? The more you connect the two solutions, the more you will deepen your understanding.

## Peer Conferencing

A few simple guidelines will help you have more meaningful conversations with your partner.

- Focus on the mathematical aspects of the solution to the problem **and** how they were communicated.
- Ask questions. Encourage your partner to ask questions. Discussing ideas will help you learn.
- Demand meaningful feedback. If your partner only says "everything looks good," you learn nothing.
- Practice revisions to your explanations (verbally) before writing them. This is a unique opportunity to get instant feedback on your communication. Use it!
- If both you and your partner are unsure about the solution, try to figure it out together. Talk through your reasoning, where it got you, and where it got you stuck.

## Meaningful Feedback

Use the self-reflection questions as a guide for areas you might give feedback to your partner on.

- Be specific. Saying "your explanation was unclear" is not nearly as useful as saying *why* it was unclear (e.g., "you used the term asymptote incorrectly.") If you say *why* you think something, your partner can evaluate your feedback, regardless of your confidence.
- Be constructive. As much as possible, don't just say that something needs to be improved, but suggest how it could be improved (e.g., "asymptotes *can* be touched by the function; you know you have an asymptote because you have a certain limit").
- Try to help your partner learn. If the solution seems to indicate misunderstanding of a concept, spend time talking about that concept until both you and your partner are clear on it. Explaining and discussing concepts with your partner will help you understand them better.

## Not Very Meaningful Feedback

Here are a number of examples of feedback that are not very helpful for you partner (*explanations why in italics*). Please refrain from offering these types of feedback.

### Communication:

- Everything looked good. (*Even the best solutions can be improved. Put more effort into thinking how your partner could do so.*)
- Your solution was explained well. (*This feedback not only doesn't say what about it was explained well, but it also doesn't help your partner improve.*)
- Your solution could use a little bit more explanation. (*Tell your partner exactly what needs more explanation and try to suggest how they could improve their explanation. Remember, simply adding **more** isn't **always** better.*)

- Your explanations were a little unclear. (*You need to tell your partner what exactly was unclear, and try to suggest how they could improve it. Try focusing on what you couldn't understand or where you got lost.*)
- Show a little bit more work. (*Tell your partner exactly where you got confused. You need to be more specific with your feedback.*)

**Correctness:**

- I found an error in part (e). (*Tell your partner what the error was and why it was incorrect.*)
- Your answer to part (a) needs improvement. (*Tell your partner what was wrong and how to improve it.*)
- I think your solution is wrong. (*Tell your partner what the error was and why it was incorrect.*)
- Be sure to finish the problem. (*Your partner probably didn't finish the problem because they didn't know how to. Instead of telling them the obvious, try to help them figure it out.*)
- Everything looks good. (*What evidence do you have for saying this?* )

**Strategies for Facilitating Peer-Conferences**

Sometimes it may feel like you don't know what to say or how to get better feedback from your peer conferences. If your partner simply says "it looks good," it does nothing to help you improve. PAR is a unique opportunity to get feedback and talk about the mathematics in a problem, so make sure that you take advantage of it! Here are some suggestions for things you might say or ask in order to have a more productive conversation. One key strategy is asking questions about specific aspects of your solution or your partner's solution. Here are some suggestions:

- I was struggling with how to communicate X, do you have any suggestions?
- Would it be all right if I practiced my explanation with you before I revise my solution?
- Did you check all of my calculations, and did you find any errors?
- I noticed that we did the problem differently. Can we look together and make sure our solutions are consistent?
- I was unsure about (concept X, or how to do X). Can we talk more about it?
- In your solution, I noticed that you did X. Can you explain why?