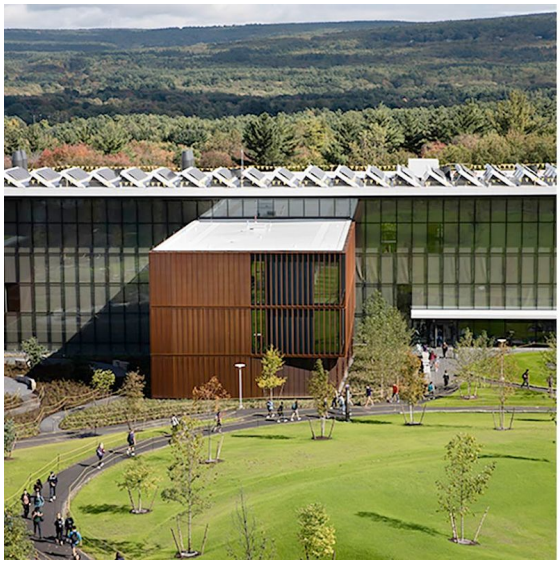
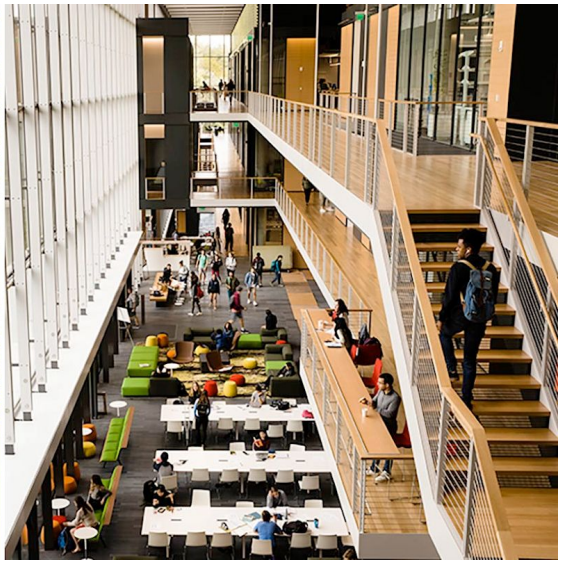
HSTEM Inclusive Curricular Practices Handbook

Inclusive practices in STEM for lecture and the laboratory
(that work for ALL disciplines!)

Version 3. January 2020

HSTEM began as a special topics course in the spring of 2016 with the goal of understanding and enhancing the STEM climate at Amherst College. Building on three semesters of HSTEM student efforts, a group of faculty and staff put together the first edition of this handbook in August, 2017 to help support faculty, especially STEM faculty, in making easy, effective and evidence-based modifications that promote inclusivity and success. If you have received a copy from a colleague, please consider scanning the QR code above or clicking on the handbook icon under the "HOW TO HSTEM" tab at www.beinghumaninstem.com to let us know that you're using our resources so we can demonstrate the positive impact of HSTEM at Amherst and beyond!

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Introduction

1.1 HSTEM Curricular Initiative Goals

Being Human in STEM (HSTEM) is a student-initiated collaboration with faculty and staff working to strengthen our STEM community.

The aims of the curricular initiative are to:

- Create an inclusive learning environment that begins in the introductory courses
- Implement practices that promote engaged learning and shared responsibility for a thriving STEM community for all
- Foster students who see themselves and diverse others as capable of succeeding in STEM, while honoring their unique and shared identities

The process of creating this handbook began with the academic inquiry of HSTEM students into the literature on inclusive practices and outcomes in STEM and giving voice to Amherst student experiences in STEM through interviews. After sharing their research and insights the greater community of faculty and staff, HSTEM students turned their focus to developing and compiling tools that would be useful to the unique Amherst environment.

Building on these student efforts, a group of faculty, staff and students assembled selected practices and drafted this handbook to support faculty and staff in experimenting with new approaches to enhance the learning of every student in our classrooms. Faculty members across STEM departments have implemented practices from this handbook across STEM courses since the handbook was first introduced at the Dean's Inclusive Pedagogy Retreat in August, 2017. Over 300 copies of the handbook have since been distributed and downloaded from our website (www.beinghumaninstem.com) to faculty at Amherst and beyond

We encourage any interested faculty to try incorporating these practices into their teaching. We would be glad to support these efforts along with the Center for Teaching and Learning. We encourage you to share your experiences with these practices with us, by contacting us.

1.2 HSTEM Origins

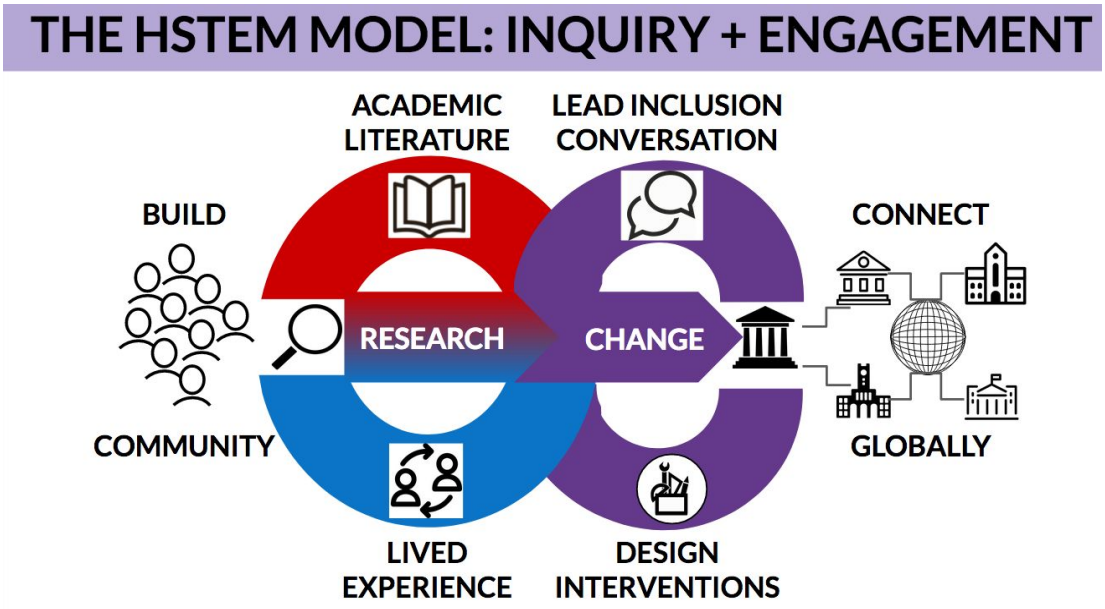
Article discussing HSTEM's origin by Prof. Sheila Jaswal
"From Student Protest to Institutional Protest: Being Human in STEM"
https://www.aacu.org/diversitydemocracy/2019/winter/jaswal

Amherst Uprising

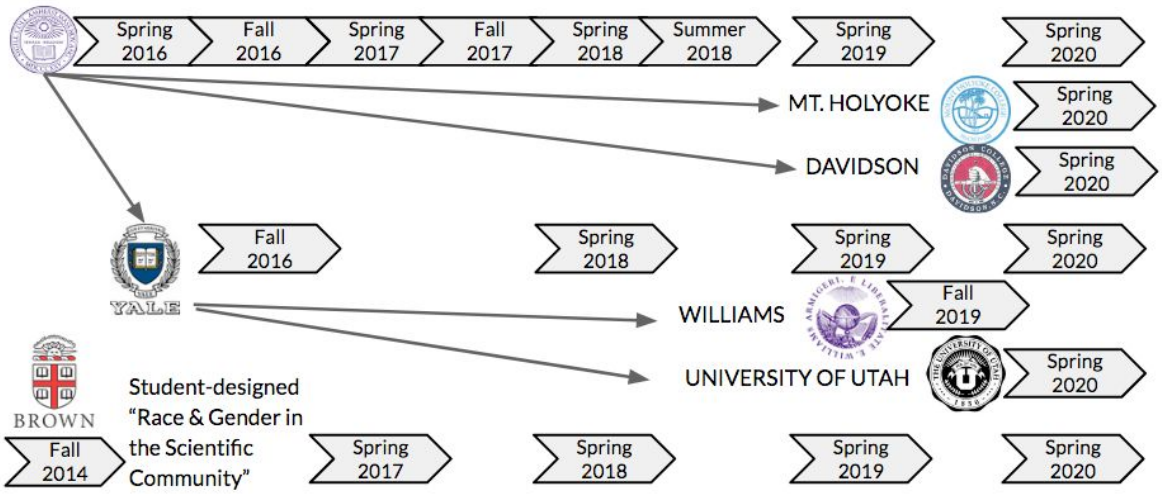
- November 2015, 4-day sit-in called "Amherst Uprising"
- Discussion about feelings of inclusivity during the college experience, tied closely with events at other colleges and universities having similar conversations
- Attended by students, staff, and faculty- community transformation
- Positive changes made, with STEM-wide statements of support

Being Human in STEM course

- Discussions between Dr. Sheila Jaswal and students during Uprising
- Student-driven, project-based course began spring 2016
- Build class community, investigate the academic literature on STEM inclusion and the local STEM experience, use that foundation to lead campus conversations & design locally effective interventions grounded in evidence, and connect beyond campus with other STEM inclusion initiatives



- Interest from different Amherst constituencies and other institutions
- Movement spread to Yale, which implemented its first course in the fall of 2016, allied with similar Brown course in spring of 2017, as of spring 2020, the HSTEM network also includes University of Utah, Williams, Mt. Holyoke and Davidson Colleges.



Join Us!

After 3 semesters of the HSTEM special topics course, students wanted to focus on impacting STEM at Amherst by putting into action what we have learned. Building on the HSTEM student efforts, a group of faculty and staff put together this handbook over the summer of 2017 to help support faculty, especially STEM faculty, in making easy, effective and evidence-based modifications that promote inclusivity and success. Many require little effort and can easily be integrated into your course tomorrow!

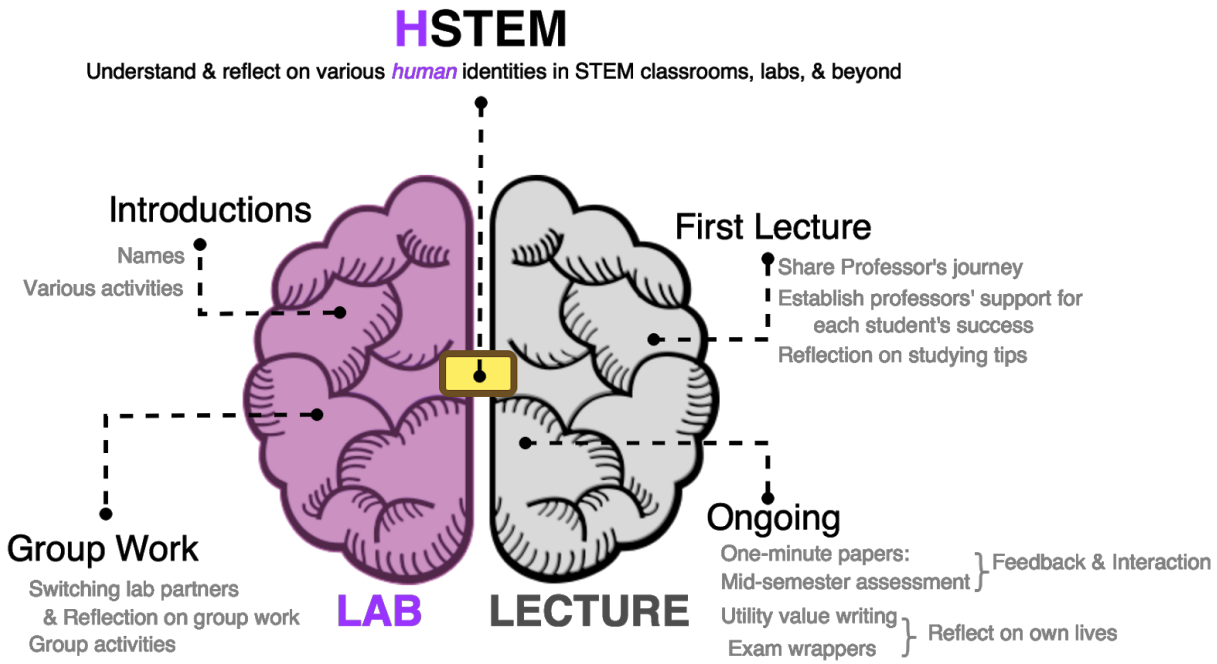
To identify one or more modifications that might work for you, check out the overview of the suggested practices in Section 2. Flexible detailed instructions and references supporting the effectiveness of each activity are provided in Sections 3 and 4 and templates for handouts and slides are available in a shared Google Drive folder by request. The Center for Teaching and Learning is happy to work with individual faculty, regardless of discipline, to customize materials for your course needs.

Since the launch of this handbook, faculty and staff at Amherst have attended various HSTEM, CTL and Science Center gatherings where we have discussed our experimentations with these practices, and learned from each other. In addition, Dr. Sarah Bunnell from the CTL has been working with HSTEM practitioners to help assess the impact of HSTEM practices. We hope to contribute to the ongoing conversations around teaching excellence at Amherst by sharing the results with the community. We look forward to welcoming you to our community whether you integrate inclusive practices now or in the future!

2.1 Overview: Incorporating HSTEM practices into your course

Lecture & Laboratory Strategies

- Foster a relationship of trust and understanding between the professor and students by humanizing the professor through sharing a personal STEM narrative
- Establish an inclusive community through intentional activities that enhance belonging and shared responsibility for learning
- Provide opportunities for students to connect the success of these practices in the classroom environment to supporting their future academic and career goals as lifelong learners and community leaders



I'm teaching a lecture and want to incorporate:

Activity	Gain	Efforts Needed
1st class activities	• Models how to build a community and connect as a human in STEM • Positive and memorable first impression of the multidimensional human side of professor • Helps students identify with professor and STEM by emphasizing human aspects	• ~25 minutes • To share your own story, have to be vulnerable • Share some class leadership responsibilities with students
One-minute papers	• Immediate feedback on a lecture and/or activities • Students engage with material immediately and can articulate questions • Encourages synthesis and making creative connections across course materials and prior knowledge • Students can feel heard in a large lecture	• Printing the template • Time to hand out the one-minute papers and collect them (can use help of TA, if available)
Utility value writing	• Research demonstrating that students learn better through this activity • Makes connections to the material in diverse ways • Improves writing in STEM	• Printing the template • Time to hand out the papers and collect them • Students complete out of class • Grade for completion needed
Mid-semester check-in	• Students reflect on learning • Feedback on course components • Opportunities to reach out • Shows willingness to listen • Opportunity to adjust course • Improves student evaluations	• Printing the template • Decide on changes to respond to the feedback • Report back to class
Exam wrappers	• Students use actual performance levels to reflect & change studying strategies ○ Craft their own responses to improve • Models how to learn from mistakes • Sends message about learning, not performance, by having them revisit the material post-exam	• Printing the template • Time to hand out the papers and collect them • Additional efforts if create form electronically • Grade for completion needed

I'm teaching a laboratory and want to incorporate:

Activity	Gain	Efforts Needed
Introduction Activity	• Learn names of everyone in the section, promoting positive communal accountability through students' sense of feeling "known" • Increases level of fun in the course to lower students' affective filters and enhance students' sense of belonging	• ~10-15 minutes on the first laboratory • Depending on the activity, may require paper
Switching lab partners (w/ reflections)	• Builds a class-wide community • Students learn to work in groups • Promotes the ability to work with a variety of other people and the flexibility to use a diversity of approaches in problem solving • Feedback on student group experiences • Students reflect on their group work and their roles in groups	• Depending on method, requires cards/paper • Time to distribute the paper and reflection • ~5 min to provide feedback on the reflections
Group Activities	• Students learn to work in groups • Students learn about each other	• May require extra time for students

2.2 Contact Information

- **HSTEM co-facilitator / HSTEM Pioneer**, Sheila Jaswal, Chemistry Department, sjaswal@amherst.edu
- **HSTEM co-facilitator**, Megan Lyster, CCE, mlyster@amherst.edu
- **Associate Director & STEM specialist, Center for Teaching and Learning**, Sarah Bunnell, sbunnell@amherst.edu

HSTEM Lecture Activities

3.1 Goals

- Create inclusive opportunities in STEM classes that will enhance a sense of belonging for all students
- Explicitly guide students in charting their own course for success
- Utilize pedagogical methods that increase students' ability to see their professor as a potential mentor regardless of demographic

3.2 Activities Overview (example ppt)

1. **First class:** set expectations for developing a learning community and establish a supportive environment that welcomes all learners
    - Introduction: humanize the professor
    - Explicitly establish a tone for supportive environment and let students know that the professor wants them to succeed
        i. Multitasking activity
        ii. Defining success & how to achieve it activity
    - Share class expectations
    - Google form (or notecards) that asks students about the course: any concerns, anything else you would like me to know
2. **Ongoing course activities:** metacognition to create a community and connect students' *human* lives to the course material
    a. One-minute papers
    b. Utility value writing
    c. Exam wrappers
    d. Mid-semester check-in

3.3 Activity-Specific Descriptions: 1st day Class Activities

3.3.1 Humanize the professor

- Makes professor more accessible and provides a personal STEM narrative that students can identify with
- Professor's path in STEM, examples which might include:
    - First interest in STEM (ideally relatable to others without an early exposure to STEM as a career)
    - Challenges in STEM pathway that took overcoming
    - Love / excitement for research topic
    - Mistakes / serendipitous ways things turned out that required errors, troubleshooting & couldn't have been predicted
    - Landing at Amherst, *e.g.* lab photo(s)
- Example slide:

3.3.2 Multitasking Activity

Goals / Rationale

- Show that multitasking reduces efficiency!
- Encourage students to stop multitasking in lectures and in their studies

Literature Support

- Crenshaw, Dave. *Myth of Multitasking.*
- Gazzaley, Adam. *The Distracted Mind: Ancient Brains in a High-Tech World*
- *http://www.businessinsider.com/multitasker-test-tells-you-if-you-are-one-of-the-2-2014-5#ixzz31ngvwdvm*
- *http://www.sciencedirect.com/science/article/pii/S0360131512002254*
- *https://www.psychologytoday.com/blog/creativity-without-borders/201405/the-myth-multitasking*

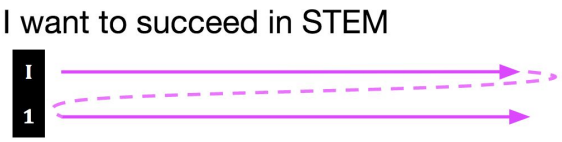
Specific Steps

Adapted from Psychology Today

1. Draft script- but make it your own:
    - How many of you want to do everything possible to succeed in this class?
    - How many of you are worried about the amount of time it will take to learn and digest the material?
    - What if I told you there is a proven method that increases comprehension of lecture material by at least 10%?
    - Don't just take my word for it, let's give it a try
2. Have 2 slides in your lecture (and handout) that have 2 horizontal lines on an empty page
3. Project the sentence "I want to succeed in STEM"
    - Could ask students whether they know what STEM (the acronym) is & define it
4. Give them the instructions summarized below
5. Start a timer, have students start, and note the time when hands go up.

Directions:

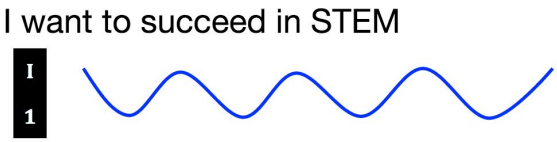
1. Copy the sentence on one line
2. Then, write numbers 1-20 on the next line
3. Raise your hand when you are done.



6. Switch to the second slide and have the students cover what they just did.
7. Give them the instructions as summarized below.

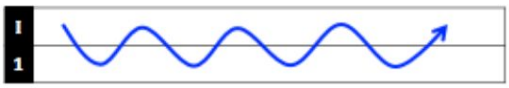
Directions:

1. Write a letter on one line, and then a number on the line below, then the next letter in the sentence on the upper line, changing from line to line.
   In other words, you write the letter "I" and then the number "1" and then the letter "w" and then the number "2" and so on, until you complete both lines."
2. Raise your hand when you're done



8. Have them raise their hand when they're done.
9. Have them estimate the difference in times, then share the times with them.
10. Project debriefing slide & let them share what they noticed.

What did you notice?



Possible prompts:

- What was different?
- How many of you have texted/surfed in class?
- Our culture propagates the myth of "multitasking" as a time-saving and productivity-enhancing practice. Based on this exercise, what will be the impact if you are texting and surfing in class?
  - On you- (will get behind, have to spend the extra time to catch up)
  - On others-(Distracting, including to the professor)
- In this class, you'll be exposed to material you're familiar with as well as completely new material.
- We all said we are committed to succeeding, this is a very easy, very effective way to make sure you can engage with the material and start the learning process immediately in class.
- This is one very specific strategy (turning off your phone and leaving it in your bag) that is guaranteed to support all of you in succeeding.

3.3.3 Defining Success & How to Achieve It

Goals / Rationale

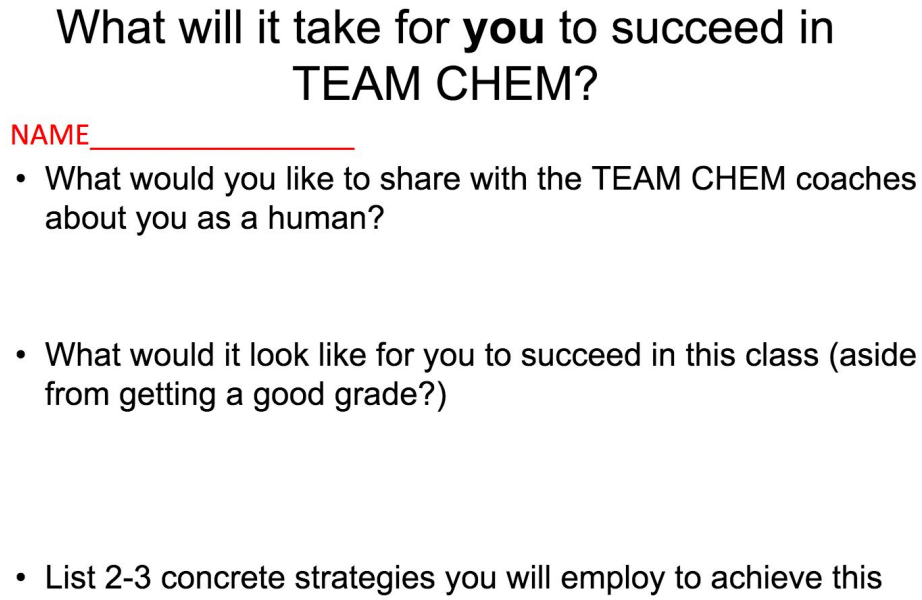
- Have students naturally discover how an inclusive environment, which promotes shared responsibility for articulating learning goals and strategies, can lead to success
- Professor initiating this discussion will show the students that the professors want to share responsibility for the class and are part of this community

Literature Support

- Dunlosky *et al. Improving Students' Learning With Effective Learning Techniques: Promising Directions From Cognitive and Educational Psychology*

Specific Steps

1. Introduce the activity
    - I want you all to be successful, but in college, it's important for each of us to define what we mean by success and to be intentional about our plans to achieve it- in the same way that many of us exercise discipline and practice in achieving goals in the arts or athletics.
2. 1-minute brainstorm on how you personally will define success in this class (aside from "getting an A") & list 2-3 concrete strategies you will employ to achieve it. Can be coupled with having the student share something about themselves with the professors.



3. Pass out the handout with 12 study tips while this quote from an Amherst '17 graduate is up:

- "We come to Amherst as one of the top students in the class, and many of us never had to worry about being above the median (or even close to the median). That will change at Amherst (and if that doesn't change, you should take more challenging courses). If you get a grade you're not happy about, don't worry about the specific grade but make sure you understand the concept. At the end of the day, you won't care about the grade you received from the class but you will care about what you learned from that class (and yes, even if you are a premed/prehealth student where "GPA matters"). Acquiring and diversifying knowledge should be your biggest goal of the Amherst College education, including in the STEM fields."

12 Rules of Good Studying from https://barbaraoakley.com/

Quotes from HSTEM & Association for Women in Science spring 2017 student survey

1. **Utilize various resources.** Even if you are not struggling with the material, have a study group to view the material in different perspectives. Explaining concepts to others is one of the key techniques for better learning. Come to office hours - we all want to help you understand the material, and can discuss various methods to study more efficiently.
2. **Ask questions.** During the lecture, if you have any questions, jot them down on a piece of paper. You can ask the question in lecture, if appropriate, or right after lecture. Ask questions to your classmates, professors, and TAs. There are no "stupid" questions, and your questions can also help others understand the material better.
3. **Use recall.** After you read a page, look away and recall the main ideas. Highlight very little, and never highlight anything you haven't put in your mind first by recalling. Try recalling main ideas when you are walking to class or in a different room from where you originally learned it. An ability to recall--to generate the ideas from inside yourself--is one of the key indicators of good learning.
4. **Test yourself.** On everything. All the time. Force yourself to explain concepts in your own words. Write your own quiz for a unit or chapter and take it. Swap with your friends.
5. **Chunk your problems.** Chunking is understanding and practicing with a problem solution so that it can all come to mind in a flash. After you solve a problem, rehearse it. Make sure you can solve it cold--every step. Pretend it's a song and learn to play it over and over again in your mind, so the information combines into one smooth chunk you can pull up whenever you want.
6. **Space your repetition.** Spread out your learning in any subject a little every day, just like an athlete. Your brain in like a muscle--it can handle only a limited amount of exercise on one subject at a time.
    - " I'd also tell myself to go over my notes for maybe 10 minutes everyday and go to office hours. This type of prolonged attention has really helped me understand the material better."
    - "Study notes right after the class, even for just 5 minutes as the professor is erasing the board or as you stand in a Grab-N-Go line. This will make your studying much easier in general and you will save a lot of time studying for exams. Also, if you don't get the material in that moment right after the lecture, chances of you understanding it a week or more is even slimmer."

7. **Alternate different problem-solving techniques during your practice.** Never practice too long at any one session using only one problem-solving technique--after a while, you are just mimicking what you did on the previous problem. Mix it up and work on different types of problems. This teaches you both *how* and *when* to use a technique. After every assignment and test, go over your errors, make sure you understand why you made them, and then rework your solutions. Quiz yourself randomly on different types of problems.
8. **Take breaks.** It is common to be unable to solve problems or figure out concepts in math or science the first time you encounter them. This is why a little study every day is much better than a lot of studying all at once. When you get frustrated with a math or science problem, take a break so that another part of your mind can take over and work in the background.
    - "If you are in the habit of studying until 5 minutes before the exam starts, it is better to stop studying an hour before the exam. Take a break, grab dinner, or maybe go on a quick walk. Nothing you do in the next hour is going to make a huge difference in your ultimate grade, and it is better to go in with a clear head than one full of facts your were trying to memorize only a few minutes ago."
9. **Use explanatory questioning and simple analogies.** Whenever you are struggling with a concept, think to yourself, *How can I explain this so that a ten-year-old could understand it?* Using an analogy really helps. Don't just think your explanation--say it out loud or put it in writing. The additional effort of speaking and writing allows you to more deeply encode (that is, convert into neural memory structures) what you are learning.
10. **Focus.** Turn off all interrupting beeps and alarms on your phone and computer, and then turn on a timer for twenty-five minutes. Focus intently for those twenty-five minutes and try to work as diligently as you can. After the timer goes off, give yourself a small, fun reward. A few of these sessions in a day can really move your studies forward. Try to set up times and places where studying--not glancing at your computer or phone--is just something you naturally do.
11. **Eat your frogs first.** Do the hardest thing earliest in the day, when you are fresh.
12. **Make a mental contrast.** Imagine where you've come from and contrast that with the dream of where your studies will take you. Post a picture or words in your workspace to remind you of your dream. Look at that when you find your motivation lagging. This work will pay off both for you and those you love!
    - "I would caution taking STEM classes without thinking thoroughly about the reasons why you want to take the class. The reason could be anything: academic enrichment, curiosity about the subject, stepping out of your comfort zone, or the class is a prerequisite. I find it is important just to have one. When things get rough in class, having a reason or two is often what gives me the motivation to push through."

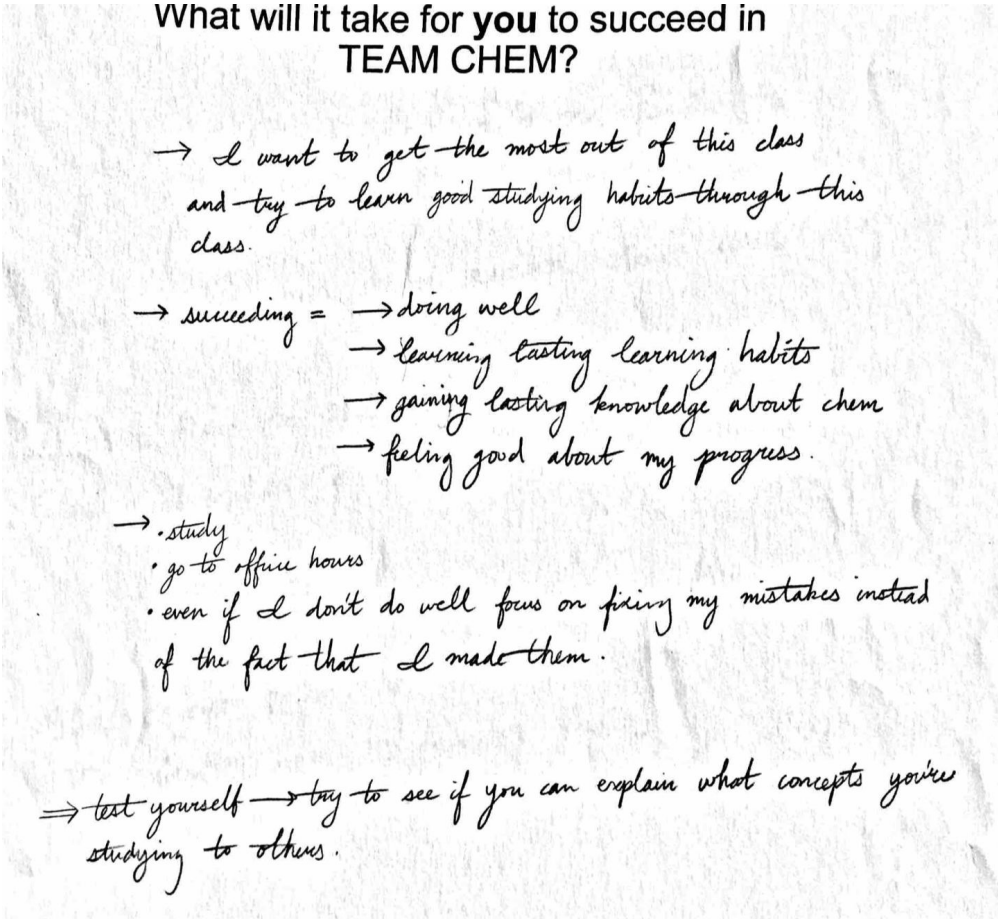
4. 3-minute reflect on non-grade goals for success and update your strategies and discuss with a partner or group of four.
5. Optional report out by groups to larger class depending on time
6. Emphasize that you hope students will refer to these throughout the semester to help focus their studying efforts.

7. Have students submit copies to you so that you can loop back to these in the larger class (especially if you are employing utility value writing) and with individual students.

Debrief

- There are multiple ways to succeed
- TA advertises the first session and the benefits: meet your classmates, discuss the material, practice explaining concepts in your own words, hear other people's questions, start habit of weekly review, get help on problems, *etc.* before the due date. Other inducements, if they exist- food, drink, *etc.*
- Advertise professor's office hours (possibly with photo of students and/or dog in your office looking welcoming)

Example



3.3.4 Share class expectations with HSTEM values

Set the tone and transition from the success discussion to the specific strategies with emphasis on HSTEM values, possibly like this example, but in your own voice: As we are thinking about definitions of success for this class, I have my own definitions of our success….

The first is that we will create a real community in this classroom

- Humans w/ respect & curiosity across differences
- Step out of limiting beliefs, whether about our own success or who belongs in STEM
- We all belong in STEM; all of us, including the instructors, believe that every one of us in this room belongs in STEM, whether it means in this class, future classes, regardless of major
- We do believe that you can all succeed, but that means defining success for yourself, which will look different
- Understanding that this allows us to learn from one another
- Respect one another, help one another.
- We are all coming to the course from different backgrounds… different places, different cultures, different experiences in STEM classes. This should be a source of strength in this class

The second is that you feel supported in your goal to be successful in this course, no matter what that definition looks like.

- When we all feel entitled to be here, respected, and valued, we can do our best learning and support each other in meeting our potential
- I will be introducing practices throughout the semester that have been shown in research studies to improve experiences and success in STEM classes, and I hope that these practices work for you
- I will try to be explicit about why we are doing various activities
- Feel free to ask me if you would like more understanding about how they can help your learning. {Sometimes value not realized until down the road…}

Third, part of the support is that you can come to office hours, or meet with me outside of office hours. My joy of teaching comes from {interacting with you, not from lecturing at you….}

The fourth {this might be related directly to the course content}. I want this to be a fun, interesting, challenging, engaging experience…..

3.4 Activity-Specific Descriptions: Ongoing Class Activities

3.4.1 One-minute papers

Goals / Rationale

- Have students connect the material to their lives (see utility value writing)
- Provide feedback to both professors and students
- Allow all students to speak up, give more opportunity to all students to ask questions
- Foster interaction and dialogue between professor and students

Literature Support

- Stead, David S. A *review of the one-minute paper*. (2005)
- *http://www.psy.gla.ac.uk/~steve/resources/tactics/minute.html*

Specific Steps / Examples: Link to an example

Adapted from University of Glasgow

- After the lecture, ask students to spend one minute writing their personal answer to 2-3 questions
    - Can be anonymous or non-anonymous
    - Can require 1, 2, or 3 per week
    - Paper is quickest and most reliable
- Questions about (select 2-3 of the following):
    - What are you confused or wondering about from today's class?
    - What's the connection between today's class material and (past concepts)?
    - What explanation/example or activity was helpful from today's class?
    - Provide a real-life example of what we discussed in lecture
    - Write a movie or song title or a joke related to today's material

How you can use these papers:

- For a large class, ask the TA to go through and pick out themes and/or just skim through
- Can be used for participation grade (for completion)
- Highlight common confusions in the next class
- Point out an activity/example that got both rave and poor reviews to highlight different learning needs
- For class morale, you can show good examples of material-related creative submissions
- Point out examples of questions that synthesize or point forward (also sometimes useful for recommendation letter material)
- Can use to help structure discussion problems and activities

- Can offer additional resources specific to students' questions- can ask TA to help find those and share!
- In general, helps students feel like you are listening and their comments matter
- Could be in the next class, or during a discussion section
- Often surprising and positive what students find helpful and actually don't complain about...

1. Summarize the main point(s) of today's class:
   - we discussed ways to measure stability when the fraction of N to U varies one very strongly.
   - we can add denaturant/heat protein in order to achieve a good ratio of U to N.
   - we began characterizing Mb function using K's & $t_{1/2}$
2. What is still confusing to you after today's class?
   I am confused about how you go from the K obtained from a graph to an equation for free energy → basically, how the rate tells us something about the energy.

3. What activity/example was helpful to your understanding?
   Having the graphs directly beneath the Reaction helped me follow what was happening energetically as Rxns proceeded.

Lecture 19 de-brief

Confusions
- How does F2,6-BP activate II
- Fructose 2,6BP formation
- how hexokinase works
- why oxidizing if favorable and makes the reaction more readily happen IIII
- some steps IIII
- role of Mg2+
- different energy diagrams
- why does G6P cleavage lead to 2C and 4C compounds?
- PFK-1 regulation IIII
- enzymes' involvement in pathway
- some other energy sources?
- how to attack problems
- can you couple reactions between separate steps?
- are there entirely different pathways that break down other molecules for energy?
- why keep low [1,3,BPG] if you want to drive conversion into something else?
- If hexokinase waits to bind ATP until after it can be safely protected from H_2O's hydrolysis, how does ATP get there in the 1st place without being hydrolyzed?
- how is it favorable to break a ring?

Helpful
- looking at each enzyme
- each step fo glycolysis broken down
- extensive analysis of glycolysis step 1
- brainstorming why graph of ATP effect on hexokinase made sense III
- step by step slides/going through glycolysis in such detail! IIIII
- talking with group about code M III
- animations
- talking to your neighbor/row III
- diagrams III
- organic chemistry arrow pushing II (metabolism mayhem- the best!)
- sprinting times that use up ATP
- ATP sources during exercise

3.4.2 Utility value writing

Goals / Rationale

- Provides opportunity for students to connect specific concepts in the course to their own lives
- Has been demonstrated to increase performance and retention in STEM, especially of URM and first-gen students compared to control in Biology classes at University of Wisconsin

Literature Support

- Harackiewicz, *et al.* *Closing Achievement Gaps With a Utility-Value Intervention: Disentangling Race and Social Class*

Specific Steps: Link to an example
Adapted from University of Wisconsin

1. Instructions:
    - Describe something we covered during this unit that you think is really cool and/or you are proud of having mastered.
    - Select the relevant information from class notes and the textbook, and write a 1–2 page essay explaining the concept, why it's important, and how it's relevant to your life.
        i. Be sure to include some concrete information that was covered in this unit.
        ii. Be sure to explain how the information applies to you personally and give examples.
2. Essays can be graded for completeness by TAs and counted towards participation grades.
3. If you have time, provide brief, but authentic feedback that echoes students' own feelings of success. This will reinforce the idea that you value each individual's success in your course.

Examples:

Exam 2 Utility Value Writing

1. Describe something we covered during this unit that you think is really cool and/or you are proud of having mastered.

I think the ideal gas law is pretty neat! The ideal gas law (PV=nRT) describes the relationship between pressure, volume, number of moles, and temperature. I like that there are multiple applications of the gas law, and it can tell you so many different aspects of a given situation.

2. Using relevant information from lecture material, textbook, and laboratory, write 1–2 paragraphs explaining the concept, why it's important, and how it's relevant to your life.
    - Be sure to include some concrete information that was covered in this unit.
    - Be sure to explain how the information applies to you personally and give examples.

The ideal gas law uses Boyle's law, which describes the inverse relationship between pressure and volume. It combines Boyle's law with Charles' law (relationship between volume and temperature) and Avagadro's law (which shows the relationship between volume and moles). I thought the lab in which we used the ideal gas law to determine the composition of an unknown was very cool. I liked seeing how close my calculated values were to the experimental valves- that was exciting.

Boyle's law is relevant to me because I love going to the mountains, where the pressure is lower than it is at my house. This means that when I'm driving to the mountains with a bag of my favorite sweet potato chips I have to be careful. The pressure decreases so the volume has to increase, meaning that the bag might pop and it makes a super loud bang and I scream because I think someone is shooting at me.

1. Describe something we covered during this unit that you think is really cool and/or you are proud of having mastered.

   While I wouldn't say I've mastered it, I think the Schrödinger Equation is really complex and interesting. It's written out mathematically by $\widehat{H}\Psi = E\Psi$, which is a notation I had never seen before, but am now proud to say I understand.

2. Using relevant material from lecture material, textbook, and laboratory, write 1-2 paragraphs explaining the concept, why it's important, and how it's relevant to your life.
   - Be sure to include some concrete information that was covered in this unit.
   - Be sure to explain how the information applies to you personally and give examples.

   The Schrödinger Equation is an improved version of Bohr's model, that provides a set of energy levels that match the energies calculated in Bohr's model, but also works for all other atoms. The Ψ^2 also provides the probability density of the electron. From the Ψ in the Schrödinger Equation, we can derive the three quantum numbers, *n, l,* and m_l. With these quantum numbers, we can tell the size/energy, shape, and orientation of an atom.

   In high school chemistry, I really struggled with the concept of orbitals. Now that I have a relatively good understanding of the Schrödinger Equation and the quantum numbers, I can really visualize the orbitals and understand their significance. Being able to understand a concept that I used to really struggle with has encouraged me to continue to try and understand more topics in chemistry, rather than accepting that I can't do it.

3.4.3 Exam wrappers

Goals / Rationale

- Have students reflect on their exams and they studying methods they used
- Give feedback to the professors

Literature Support

- Kaplan, *et al. Using Reflection and Metacognition to Improve Student Learning*.

Specific Steps

Adapted from Carnegie Mellon University

1. Return the midterm.
2. The following class: talk about the metacognition piece
    - Explain the exam is a process for learning about how you learn, and we are going to help you do that with this exam wrapper (due next class)
    - Questions on the handout (or electronic form): Link to an example
        i. Describe the specific strategies and the percentage of time you spent on each in studying during this unit.
        ii. What surprised you about your experience with the exam?
        iii. Where did you have trouble on the exam?
        iv. Which specific strategies will you continue and which will you change to prepare for the next exam?
3. Collect the completed wrapper the following class
4. Grade the wrappers for completion
5. Return so that students use them for the following exam
6. Share with the class common themes, challenges and strategies.

Possible uses

- Have individual appointments available with TA and professor for students to discuss the exam
- Reach out to students who struggled on the exam and invite/require them to come talk to you about how you can work together to help them learn the material more successfully
    - "*If a student doesn't do well on an exam, don't assume that they aren't coming to you for help or advice because they don't care. It makes a huge difference to have a professor care enough to reach out when you are struggling.*" - former student
- For a large class, can announce "anyone who is not happy with their exam, please come to my office hours because I would like to help you."

Examples

CHEM151 Exam 2 Wrapper **Name:**_____

This activity is designed to give you a chance to reflect on your exam performance and, more importantly, on the effectiveness of your exam preparation. Doing well in challenging situations requires effort, strategy and self-efficacy. Self-efficacy doesn't just happen; it requires intentional thought, something we will do here. Regardless of how satisfied you are with your exam performance, thinking about how you arrived at that performance will be helpful to maintaining or adjusting your exam preparation as needed.

1. Approximately how much time did you spend preparing for the exam? 12 hrs

2. What percentage of time your exam-preparation time was spent in each of these activities recommended in the exam 1 preparation guide?

   a. Lecture handout review yus ~5%.
   b. Written assignment review yus ~5%.
   c. Madra assignment review yus
   d. Reworking challenging problems yeet → 10%.
   e. Working new problems from Zumdahl eh
   f. Writing out your own study guide yuh ~5%.
   g. Rewatching videocast excerpts YES ~50%.
   h. Reading relevant textbook sections for the first time dah (no)
   i. Rereading relevant textbook sections eh
   j. Making your note card yass ~25%.
   k. Other
      Please specify:

3. Describe the specifics of your top three exam preparation strategies from above. (i.e. answered objectives, talked through slides, used Madra feedback to focus studying, etc.)

I re-watched all the videocasts, then took notes on these videos. I went through the study guide and made a bangin' notecard, which helped me very much to study. I also spent a lot of time and scratch paper writing out and solving difficult problems from previous assignments / handouts.

4. Now that you have looked over your graded exam, estimate the percentage of points you lost due to each of the following (make sure the percentages add up to 100)
   a. Algebra or arithmetic errors 25%
   b. Lack of understanding of the chemical concepts 25%
   c. Not knowing how to approach the problem —
   d. Not showing my work —
   e. Incomplete (or wrong) explanations 50%
   f. Careless mistakes —
   g. Other —
      Please specify —

5. What surprised you about your experience with the second exam?

I think I was pleasantly surprised with my efforts finally carrying over to my grade.

6. Considering also your responses to the previous questions and reflecting back to your first exam, were there any changes you made in your studying? If your first and second exam scores differ significantly, what do you think have changed?

Yes. I focused more on the lectures than the study guide itself. Also, meeting with professor Innes is so very helpful

7. Do you need any outside support to improve your learning and preparation for the final exam? We welcome any suggestions here.

I got this.

3.4.4 Mid-semester Check-in

Goals / Rationale

- Hear student feedback on course activities
- Give students opportunities to reflect on their own studying
- Opportunity to make adjustments to the course that benefit the student and you
- Demonstrates constructive incorporation of student feedback, showing responsiveness & flexibility

Literature Support

- Karron, Lewis. *Using Midsemester Student Feedback and Responding to It* (2001).

Specific Steps: Link to a blank template

1. Mid-semester, ask students to fill out a form to reflect on their own studying and give feedback on the course with a focus on learning.
    - Doing it in-class with paper is most reliable, could be done electronically
    - Center for Teaching & Learning staff will assist with crafting appropriate questions, administering the survey, and compiling and interpreting feedback
2. It is critical to take a few minutes during class time to communicate to the students what you have heard, what you are changing, what you are not changing, and why.
3. Can encourage students to come to office hours to discuss their results
4. For smaller classes, can arrange individual meetings

Example:

Hours per week I spend on Biochem

6

What I'm doing well to learn Biochem

Going back to listen to the lectures to supplement my notes in class
Asking lots of questions

What I could do better to learn Biochem

challenge myself to apply concepts learned in class to real situations

What's working about the course and its components (be as specific as possible) to help me learn Biochem

- TBL and the lecture recordings are both very helpful
- The amount of office hours (especially around exam time) is a useful resource

What specific changes to course components would I suggest to better help me learn Biochem

nothing I can think of at the moment :)

What I would like Dr. J to know:

You are a super excellent professor! I love how you engage everyone during lecture, TBL, office hours, and outside of the classroom.

HSTEM Laboratory Activities

4.1 Mission & Goals

- Create a community by working in pairs & groups
- Learn to work in groups, so that students learn these skills for the group work in their careers

4.2 Activities Overview

1. First week: introductions & course expectations
    a. Introduction activities

    Choose an option you feel comfortable doing in your class. You may also choose your own introduction option if you prefer another. Here are some resources on the Center for Teaching and Learning website.

        i. The Name Game
        ii. General Introductions
        iii. Airplane game
        iv. Partner Introduction

    b. Class expectations script

2. Ongoing Lab activities: group activities & group formation
    a. Group formation: switching partners
    b. Group activities
    c. Reflection on group work

4.3 Activity-Specific Descriptions

4.3.1 Introduction Activities

Goals / Rationale

- Learn names to promote positive communal accountability through students' sense of feeling "known."
- Increase level of fun in the course to enhance students' sense of belonging by helping them lower their affective filters.
- Establish a foundation for continuing relationships that can serve as a support and resource network throughout their (academic) careers.

A note about pronouns. There is ongoing discussion about how to be inclusive of non-binary and other individuals who do not use she/her or he/him pronouns during group introduction scenarios. Amherst Professor Jen Manion, a self-identified gender outlaw, wrote a piece about the discomfort and anxiety that can arise when being put on the spot to identify ones pronouns in a group setting (http://www.publicseminar.org/2018/11/the-performance-of-transgender-inclusion/), while a counter response (http://www.publicseminar.org/2018/12/we-still-need-pronoun-go-rounds/) argues that being invited to share what one goes by is paramount to making trans students feel included. One compromise is to name your own pronouns when you introduce yourself, which invites others who wish to do so to follow suit, without requiring it of everyone.

Choose an option you feel comfortable doing in your class. You may also choose your own introduction option if you prefer another.

The Name Game

Benefits: Simple, effective, quick, fun (for small classes)

Adapted from Amherst College

1. You ask a random student to say his or her name.
2. The next student says his or her name and the first person's name.
3. The third student says their name, the second student's name, and the first person's name.
4. Repeat until every student has participated and you are the only one left. You are the last in line.

An adaptation could be to share the class roster with student photos, which students can label with the names as the activity progresses. This could eliminate some anxiety and provide a reference sheet to help students in class.

General Introductions

Benefits: Simple, quick, familiar

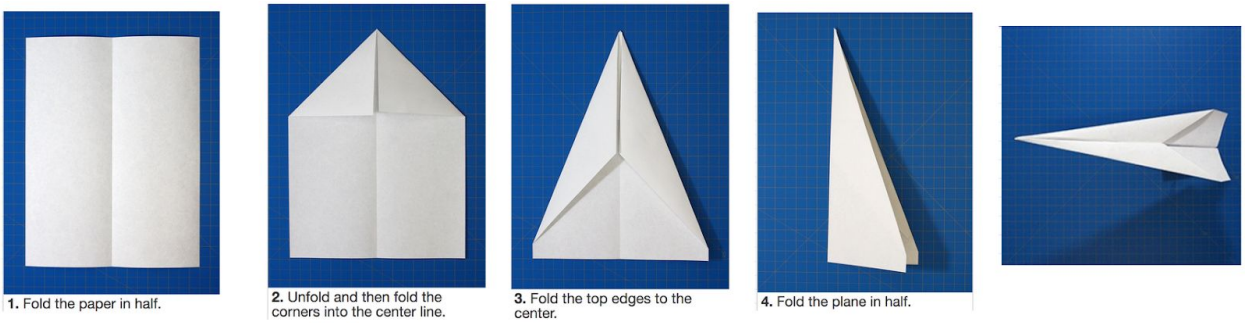
1. Begin with yourself, say your name, pronouns (see comment above), and answer a question.
2. Move through all individuals (inclusive of students, TAs, and instructors)
3. The question can be anything you decide.
    a. Examples: favorite book, favorite movie, last time you took a STEM course?
    b. More examples are available at the Center for Teaching and Learning.

Airplane Game

Benefits: Simple, fun

Adapted from https://icebreakerideas.com/quick-icebreakers/#Paper_Airplane, *airplane folding directions* https://www.foldnfly.com/1.html

1. Everyone makes a paper airplane, writes their name on it and three questions to ask another student
2. When everyone has finished, tell them to throw their paper airplane around the room.
3. Each person picks up the closest airplane to them and continues to throw the paper airplanes around the room.
4. After 2 minutes, the professor says stop.
5. Everyone picks up an airplane.
6. They find the owner of the airplane in their possession and answer two of the three questions on the airplane.
7. Each person then introduces the owner of the airplane to the group.



Partner Introduction

1. Have students meet with one other person in the room and talk for a few minutes (~2).
2. When this time is up, go around the room and have students introduce their partner to the rest of the class.

4.3.2 Lab Expectations Script

Adapt the following script to suit your needs and individual style to promote the inclusive learning community by providing background for HSTEM lab practices and how they will be implemented. These activities can couple with the practices being used in lecture. This script provides context that will allow students to become more invested in their participation in these activities.

- This class will strive to be an inclusive community, learning from the many perspectives that come from having differing backgrounds and beliefs. As a class community, we will aim to be respectful to all, regardless of ability, race, ethnicity, religion, gender, sexual orientation, economic circumstances, etc. We expect that all class participants, faculty, staff, and students, will create an environment that facilitates inquiry and self-expression, while also understanding and respecting how others' viewpoints may be different from our own.
    - Can have this printed on the laboratory handout
    - Can project in lab

- Our institution has made a commitment to inclusivity (Sample below from Amherst College)
    - Amherst Uprising (2015)
    - Being Human in STEM
    - Positive changes that are made in response to concerns that were raised.
    - STEM-wide initiative: Chem, Bio, Physics, Math, Stats, Computer sci. all involved
        - Have agreed across depts on some important strategies to implement across courses, outlined below
        - Support the learning of every individual by meeting you where you are
    - Department-specific statements after the Amherst uprising (http://www.beinghumaninstem.com/the-amherst-context.html "Department support" tab):

4.3.3 Group Formation

Goals / Rationale

- Build a class-wide community
- Promote the ability to work with a variety of other people and the flexibility to use a diversity of approaches in problem solving
- Student Outcomes:
    - Gain experience with different lab roles and responsibilities
    - Develop self awareness, confidence, and responsibility in the lab
    - Increase ability to explain and teach things to others, which allows them to have a greater understanding of the material through effective communication
- Career benefits:
    - Going to need to communicate with a lot of different types of people
    - Making sure to emphasize how important this is to our class but also to the broader picture
    - For pre-meds, important in medical school and beyond
        - *Example*: doctor must communicate with nurses, patients, other doctors, pharmacists, *etc.*
- Note: If Team Based Learning present in addition to lab, note the different goals

Specific Examples of Group Formation

Using cards is a good way to switch up groups randomly

- Playing cards: those with same number get paired
- Create subject-specific cards:
    - Periodic table of elements
    - Tree of life, phylogenetic tree
        - Base with ancestral traits
        - Branching off with derived traits
    - Biological molecules that will show up in the course
- Creative cards
    - Scientists with diverse representation (can give multiples, or a front and back for students to make a pair)
        - Women in science playing cards that can be downloaded from https://www.luanagames.com/index.html
        - Chemist trading cards https://talented12.cenmag.org/2017/

4.3.4 Group Activities

Goals / Rationale

- Build a class-wide community by working together
- Have students learn from each other and various ways to approach a question
- Plan for the week of safety video or no lab, so does not require adjusting lab schedule
- Lab can be used as a group activity if doing a lab the first week and there isn't time for another activity.

Specific Examples of Group Activities

- *Course specific* Examples include:
    a. Chemistry: field trip to geology department and find elements in the different rocks that are in the periodic table.
        i. Get into group that way and then go back and find properties of element.
    b. Bio 191
        i. Around permeability pre-lab. Will have done pre-lab outside of class first. After the pre-lab, work with group of four to discuss and try one harder example.
        ii. Nucleus activity: nucleus as center commonalities, create other organelles in cytoplasm that indicate other traits
            1. Do it in groups of 4
            2. Nucleus contains ~4 items, general items
            3. Two things as organelles: (1) unique traits and (2) something that they bring to the group
    c. Bio 181
        i. Build into observations and ideas for experiment
        ii. Use phylogenetic tree to do a similar activity as the nucleus activity

4.3.5 Reflections on Group Work

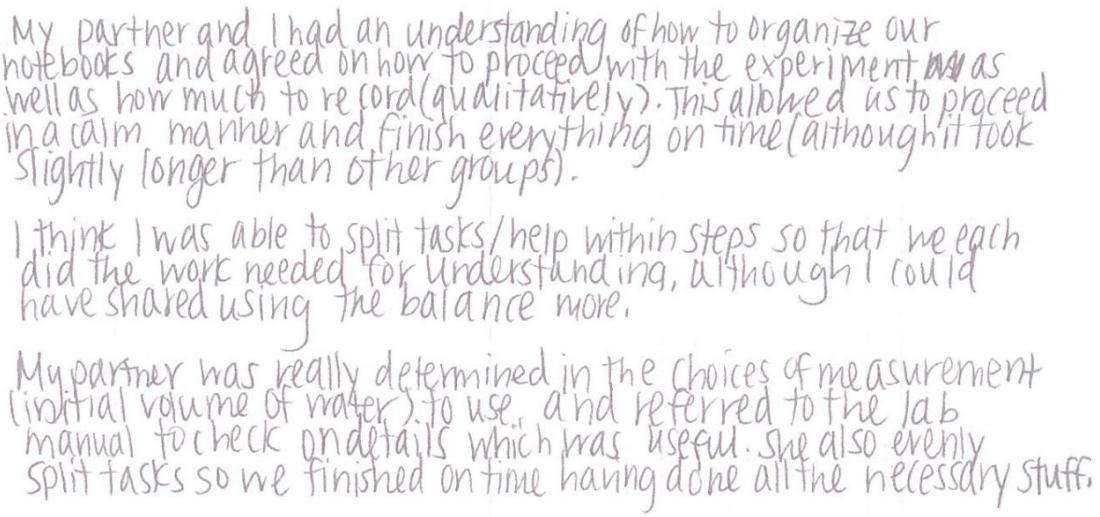
Goals / Rationale

- Create a larger community and promote awareness of what it means to be an engaged group member who supports the learning of their partners
- Provide opportunities for students to reflect and identify behaviors that enhance understanding of the material

Specific Steps: Link to a blank template

1. At the beginning of each lab, in their group:
    - Students briefly introduce themselves
    - Briefly discuss what roles in lab you prefer and how you prefer to start (ex. Jump right in or plan approach for the day)
2. Individual reflection at end of lab:
    - Can have in Moodle, 1-min paper at end of the lab, or on their own lab notebook
    - Examples: *Initially, ask the same set of questions every time.*
        - What *behaviors* from yourself or your partner(s) enhanced your experience w/ a particular lab, understanding of the material?
        - What did you do well in your group this week?
3. As needed, the lab instructor would lead a quick reflective discussion at the beginning of the following lab period to:
    - Highlight successful approaches from past weeks as well as common challenges
    - Strategize as a class ways to address these challenges

Example


My partner and I had an understanding of how to organize our notebooks and agreed on how to proceed with the experiment as well as how much to record (qualitatively). This allowed us to proceed in a calm manner and finish everything on time (although it took slightly longer than other groups).

I think I was able to split tasks/help within steps so that we each did the work needed for understanding, although I could have shared using the balance more.

My partner was really determined in the choices of measurement (initial volume of water) to use, and referred to the lab manual to check on details which was useful. She also evenly split tasks so we finished on time having done all the necessary stuff.

Additional Resources

1. Tanner, K. D. (2013). Structure Matters: Twenty-One Teaching Strategies to Promote Student Engagement and Cultivate Classroom Equity. *CBE Life Sciences Education*, *12*(3), 322–331. http://doi.org/10.1187/cbe.13-06-0115

2. Center for Teaching and Learning, Amherst College https://www.amherst.edu/offices/teaching-learning-collaborative

3. Effective Practices, compiled by HSTEM Special Topics Course in Spring 2016: http://www.beinghumaninstem.com/background-reading-on-inclusive-stem-practices.html

More resources available upon request

Acknowledgements

We recognize that we have more to learn about effective practices that are already in place across STEM at Amherst. In conjunction with the Center for Teaching and Learning, our vision is for the HSTEM Initiative to serve as a hub for sharing the collective wisdom, experience and resources of all Amherst Humans in STEM. Our efforts to date have been informed by ongoing active-learning and team-based learning strategies in Biology, Chemistry and Physics. We are especially indebted to Ashley Carter from the Department of Physics and Astronomy for providing templates for several of the activities in this handbook and to hari stephen kumar, former Director of Instructional and Pedagogical Design Services for providing crucial support for initial experimentation with many of these practices at Amherst, without which the HSTEM collaborative would not exist. Finally, we are grateful to the Dean of Faculty for funding HSTEM materials, events and participation in national conferences, the Center for Teaching & Learning and Center for Humanistic Inquiry for funding HSTEM events, and the Department of Chemistry for funding the 2017-2018 and 2018-2019 HSTEM Pedagogy Fellows.

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