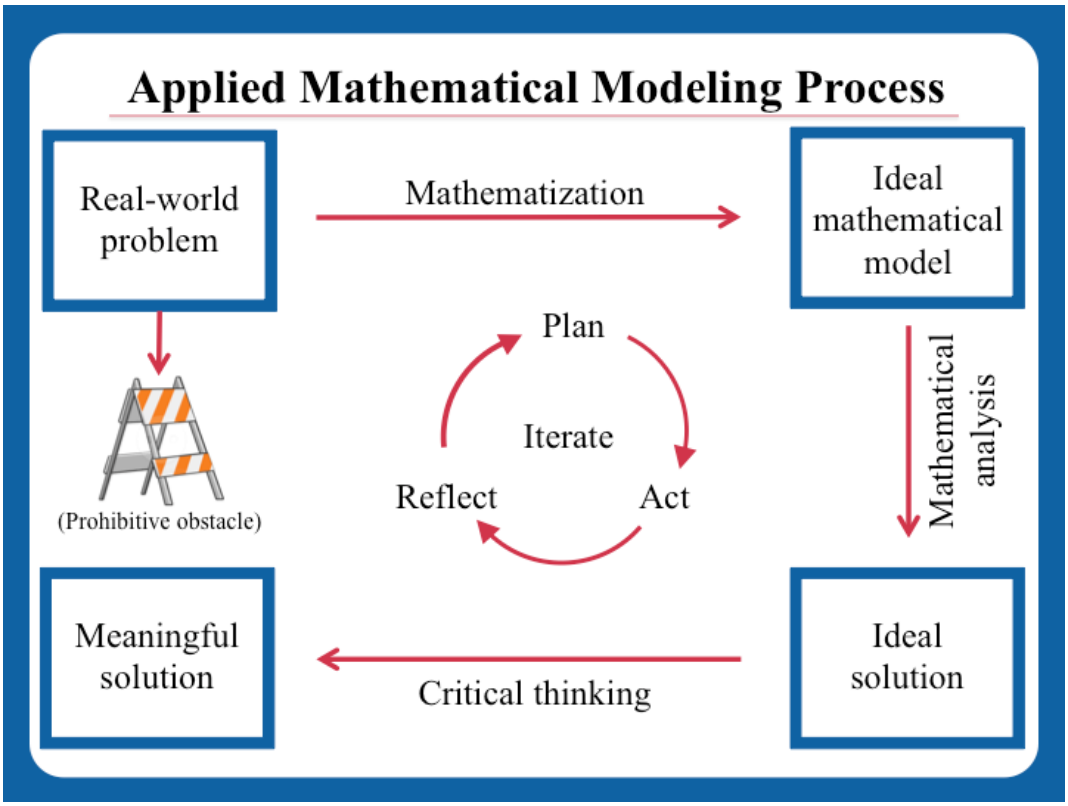
Welcome

Math 2B: Applied Linear Algebra Spring 2021



"Mathematics is the art of reducing problems to linear algebra."
-William Hart

WELCOME TO MATH 2B!

Greetings and welcome to our class. My name is Jeff Anderson. I am honored to be your instructor. I am also excited to act as a coach and mentor as you learn in this class.

My primary goal is to inspire, encourage, support, and guide you to create significant learning experiences during our six weeks together.

I believe that you can learn anything you want to and that you can thrive in any college classroom. I want to be part of a team of people that help you develop sophisticated learning practices. I hope that you can leverage your learning skills to achieve your academic, career, and personal goals in college and beyond. Si se puede!

~Jeff Anderson

Course Information

Course Title:	Math 2B: Applied Linear Algebra
Section:	01-Virtual
CRN:	40215
Lecture Meets:	Mon/Wed 1:30pm – 3:45pm
Meeting ID:	940 8980 3750
Prerequisites:	C or better in Math 1C
Homepage:	http://www.appliedlinearalgebra.com/blog/for-students/welcome-to-math-2b

HOW CAN I SERVE YOU?

I exist at this college to serve you. I want to speak with you individually at least once a week. Here is how to stay in contact with me:

- Speak to me before, during, or after class.
- Send me a private Zoom chat during in-class meeting.
- Sign up for an appointment during my student hours.
- Text me at my Google voice number: (650) 383 - 7194
    - You can text me here any time, day or night: 24 hours per day, 365 days per year.
    - I turn off notifications on my phone at night. I also limit the number of times I check my Google voice account. Generally I look at my Google Voice texts each week, Mon – Thurs between 9:45am – 4pm.
    - If I don't respond, please do feel free to follow up with me the next time we see each other or re-send your message. I ask you to be patient. This quarter, I will serve more than 110 students and there is only one of me.
- Call my Google Voice number and leave a voice mail.
- If you don't have a phone or cannot easily make contact with a United States phone number, please let me know this during our Zoom session. We can find other ways to be in contact for students in this situation.
- For technical questions arising as you watch our YouTube videos, please share your questions in the comments on that video.

AT A GLANCE: LOGISTIC ASPECTS OF THIS COURSE

HOW DOES ATTENDANCE WORK?

I believe that the most precious gift you give our class is your presence. I respect your commitment to your education and honor our shared time together. I will do everything I can to make our shared class time rich and meaningful. I hope I can earn your trust and earn the gift of spending time with you every day. So I ask you a few questions:

- What do I have to do as your instructor so that you feel excited to come to class?
- How can we, as a community of learners, create an environment in which you want to be in class?
- What expectations do you have for yourself, in terms of attendance?
- How many days do you plan on attending class?
- What might prevent you from coming to class?
- How do you feel about texting me if you miss class to keep me posted on how you are doing?
- What special circumstances do you have that might cause you to miss class?
- How many absences are too many for you?

I want to make this class so special that you feel a special warmth in your heart when you think of our class. I hope you will join me in this quest.

LATE ARRIVALS

I want to do everything in my power to help you get to class on time. You are paying me to help you learn. You are my boss. Seriously: your attendance is how I put food on my table. And as my boss, I promise to be honest with you. I can say with all my heart: I believe that one of the best gifts you give our class is your presence.

However, I also know that stuff happens. If you have something come up that causes you to be late for class, don't worry. Show up when you can. Your health and well-being is the most important aspect of our course. If you need to show up late, I'd love it if you would shoot me a text on my Google Voice number to keep me posted. I consider my students to be part of my family. When I see you are not in class, I worry about you.

HOW DO LATE ADDS WORK?

Students not officially enrolled prior to the first day of the course need an add code to add this class. Unless there are special circumstances, I do NOT hand out add codes. I have a hard enough time serving the students enrolled in our class on the first day of the quarter. For those students who need an add code, I thank you so much for your interest in this course. I'm happy to share with you my future teaching plans if you want to try to enroll in my course again in the future.

WHAT IS AN INSTRUCTOR DROP AND WHEN MIGHT THIS HAPPEN?

An instructor drop occurs when I, as an instructor, officially drop a student from this course. As the instructor of record, I have the ability to do this via MyPortal. However, I rarely use instructor drops. If you engage with me about our class and show a commitment to your learning, I will not drop you without your permission. Period.

On the other hand, I may use an instructor drop for a student who disappears from our class. I may also drop a student who makes little effort to communicate with me and who does not manage their own learning.

FYI: I am required to give a letter grade to anyone enrolled in our class after week 8 of the quarter. If you are struggling in this course, please come talk with me. There are many strategies we can use to help you get back on track. In rare instances, I have students decide to withdraw from our course due to personal circumstances outside their control With this in mind, I encourage you to pay attention to the drop dates listed on Foothill's website or listed in you MyPortal account page. Students who remain enrolled in this class beyond the published withdrawal date, as stated in the class schedule, will receive a letter grade in this class. The date to drop without it showing up on your transcripts is the end of the second week of classes.

LEARNING MATERIALS

☐ Required:	**Internet Access:** You'll need daily Internet access and access to a printer. Our course homepage features all of the learning resources we use in this class and you'll need to be able to access those on a daily basis.
☐ Recommended:	**Applied Linear Algebra, 2E** by Peter J. Olver and Chehrzad Shakiban (ISBN 9783319910413)

BEFORE CLASS: LEARN BY YOURSELF

The fact that you are in this class is a testament to your courage and curiosity. You are pushing past the frontiers of your knowledge to grow your brain and learn something new. Out of respect for that process, I want to help you learn slowly and deeply.

I believe that when I create a classroom environment that constrains the amount of time you have to think about and play with new ideas, I make learning harder and less meaningful for you. On the other hand, if I create a learning environment that allows you lots of flexibility in how you engage with material, I help you make learning more meaningful.

These beliefs are based on results in the science of learning. In fact, there is ample evidence to suggest that the practice of lecturing is harmful to student learning. There is also a bunch of neuroscience research that indicates that depth of mathematical understanding is much more important than the speed of mathematical thinking. It is with this in mind that I have made a decision to stop lecturing during our in-class meetings.

Instead, I have spent the last decade of my life creating YouTube videos to support student learning. You can find links to our course videos on our course homepage or on my YouTube channel. These videos are publicly available free-of-charge. You can watch these any time, day or night, 24 hours a day, 365 days a year. In addition to these videos, I have written a draft textbook manuscript with custom content for this course. I provide portions of this manuscript on our course homepage.

My goal is that you will watch the videos and engage with the content prior to the start of each class. In other words, I have structured our learning environment using a Flipped Classroom model. This method of learning and working together might take us a few weeks to get used to. We'll work as a team to help you adapt to this environment and figure out how to learn in this flipped learning environment. To begin, you might prepare yourself to spend a few hours before each in-class meeting watching videos, taking notes, and struggling to solve problems. This preparation happens when you are by yourself in your *individual learning space(s)*.

DURING CLASS: LEARN TOGETHER

Our in-class meeting time for this course is last 2.5 academic hours per meeting. During our in-class meetings for lecture (also known as our *group learning space*), we will focus on problem solving in small groups. This quarter, you will have the chance to write your own quiz and exam problems in small teams. You will also be responsible for producing solutions to these problems together. We'll work through this process as a team to get a sense of how this works. To help guide your learning and keep us on track for the quarter, I provide you with a tentative calendar that highlights my intention for when we will discuss each lesson in class.

GRADING POLICIES

This quarter, I am trying something new called contract grading. I have a separate document that describes that policy. Please read that document to learn more. We will work through this as a team.

CLASSROOM ETIQUETTE

Emails from Jeff: I have posted most important information for this class on our course homepage. However, in some cases I will send an email out to the entire class with updates or other important information. I'll do my best to announce my plans to send emails. To help me stay on track, please check your email a few times a week for updates.

In-Person Help: I prefer to work with you in-person. The best times to speak with me are before, during, or after in-class meetings. I also make appointments during student hours. I prefer to deal with all of the following issues in-person: enrollment, attendance, your grade, exams, in-class content, suggested problems, learning needs, special circumstances, scheduling issues, student (office) hour appointments, DRC accommodations, letters of recommendation, and almost all other issues that come up.

Text with Jeff: If you need to contact me outside of our normal in-class meeting times, please feel free to text me on my Google Voice number at (650) 383 - 7194. If you're not sure that I know who you are, please include your full name and the name of our course (MATH 2B).

Emails to Jeff: Please do your best NOT to send email me unless I specifically ask you to do so. I do not like my students to send me emails. I serve more than 110 students this quarter and work with over 100 colleagues. With this many people writing me emails, I find email detracts from my ability to serve you as my student. If you'd like to hear more about this policy, please ask me. I'm happy to talk about it. Instead of emailing me, I prefer to speak with you in person, text with you using my Google Voice account, speak with you via zoom, or hear your voice over-the-phone. There are some very rare circumstances in which I will ask an individual student to send me an email (like when I am writing a letter of recommendation or when I want to collect exemplary student work). In these rare cases, I will request an email from that individual student during a face-to-face conversation. In general, if I didn't specifically look into your eyes and request an email, please DO NOT send me email.

Student hours: If you plan to attend student (office) hours, please make an appointment. You can find open appointment times on the list of student hour appointments that I bring to class. Most student appointments last about 10 minutes. If you are unable to attend any of my regularly scheduled appointments, please speak to me about this in person. I will do my best to make an appointment with you at a different time.

I enjoy working with students during student hours. We can use this time to elaborate on concepts from class, help develop a strategy for getting the grade you want, answer questions about attending college or discuss your future plans. For more about how to take advantage of my office hours, please see the "How to Make the Most of Office Hours" handout available on our study skills website.

Cell Phones: You are welcome to use your cell phone as a learning resource while in class. If you are not using your cell phone as a learning resource, I expect your cell phones to be silent and put away during in-class meetings. If you are expecting an emergency call, you may set your phone to vibrate. Please respect your colleagues in the classroom by minimizing texting and email use in class. Of course, no cell phone use is allowed on in-class exams. On exam days, I will ask you to place your cell phones in airplane mode, put this device away in your bag, close your bag completely and place your bag under your seat.

A FOCUS ON LEARNING

WHAT IS LEARNING?

My main goal is to inspire, encourage, support, and guide you to create significant learning experiences in this class. To do this, let's define learning as a *growth process* that happens inside your brain and leads to *change*. These transformations occur based on your experiences and increase your potential for improved performance and future learning (adapted from *How Learning Works* by Ambrose et al.). Some features of this definition are worth exploring more deeply:

1. Learning is a *growth process* that takes place in your mind. Learning literally involves activating brain cells, growing new pathways in your brain, and strengthening existing connections.

2. Your brain is in a constant state of growth and change. When you dedicate more effort and struggle to master a specific skill, your brain grows more and you learn more. If you stop exercising the parts of your brain dedicated to that skill, these pathways will weaken and eventually fade away.

3. Learning involves *changes* in your knowledge, beliefs, behaviors, or attitudes. As you learn, your body and your brain physically change as well. These changes unfolds over time and cannot occur in an instant. To learn and change, you must repeatedly engage in focused practice over many days, weeks, months, or years.

4. Learning is not something that others can do for you or to you. Rather, learning is something that *you do for yourself*.

5. Learning occurs as a direct result of the strategies you use to learn as well as how you interpret and respond to your experiences. Your beliefs about yourself and the techniques you use to learn are fundamentally important in determining how your brain grows.

6. Brain growth happens most at times when we are making mistakes and struggling. Deep learning happens best when we engage in repeated productive struggle and deliberate practice.

It is worth mentioning that almost every word in the definition above has a mountain of scientific evidence to support the claims made within. Our entire class is structured to focus your energy on creating significant learning experiences in the context of studying the content of this course. I beg you to do your very best, be thoughtful as you develop new study skills, and have fun!

> "Learning results from what the student does and thinks and only from what the student does and thinks. The teacher can advance learning only by influencing what the student does to learn."
>
> –Herbert A. Simon

WHAT IS A SIGNIFICANT LEARNING EXPERIENCE?

In order to experience significant learning in this course, I believe that you need to feel that what you do in this class truly matters in your life. To help create this type of feeling, I want to inspire you to do more than simply store factual information about the course content in your short term-memory. Instead, I hope that the learning you do in this class becomes part of how you think, what you want to do in your life, what you believe is true about yourself, and what you value. As the instructor of this class, I want to help you create experiences that enhance your ability to live your life more fully and meaningfully. This is what I mean when I say I want to inspire you to create significant learning experiences.

WHAT ARE THE CHARACTERISITCS OF SIGNIFICANT LEARNING EXPERIENCES?

There are certain characteristics of a learning environment that lead to significant learning experiences. In particular, I hope you will find this class to be:

Engaging: An engaging class is one in which you feel energized and empowered to learn. In such a course, you are in charge of your learning experience. You direct and manage your individual learning processes and you actively take responsibility to create the experiences you desire. Moreover, you critically reflect on your learning processes, make changes to your strategies, and implement improvements to your study skills over time.

High energy: You can feel the vibes of a high-energy classroom the moment you walk in the door. Both you and the instructor bring a high level of energy into class during each in-class meeting. Ideally, you feel awake, alert, engaged, challenged, and encouraged each and every day we meet together.

To support you in creating this type of environment, I will help you develop measurable academic goals for yourself and connect these goals with your daily participation in class. I also encourage you to give your best effort throughout the quarter to achieve your goals. Please recognize that mistakes are a necessary part of your learning process as you master this material. If and when you make mistakes in this class, I ask you to spend focused energy correcting your mistake and working to improve your learning strategies.

WHAT ARE SOME POTENTIAL ROADBLOCKS TO CREATING SIGNIFICANT LEARNING EXPERIENCES?

I want you to be aware that we face a few huge challenges that are designed into this class:

Challenge 1: We are tasked with studying over 200 pages of mathematical theory in 11 weeks of class. Much of the theory in this course forms a foundation for graduate-level applied mathematics courses.

Challenge 2: Our college system assumes that on the day this course begins, you have fully mastered every topic from previous calculus classes and that you have no weaknesses on any topic from previous courses. Moreover, we generalize and abstract many topics from previous classes in subtle and creative ways. If you are anything like me, this assumption is absurdly false. Thus, if you do have weakness from previous classes, I will encourage you to spend extra time filling the gaps before you start in on the new material.

Challenge 3: Our college system assumes you have a very well-developed life plan and that you have thought deeply about how the material in this class fits into your plans. Our system also assumes that you have professional study skills to manage your time and energy on a day-to-day basis.

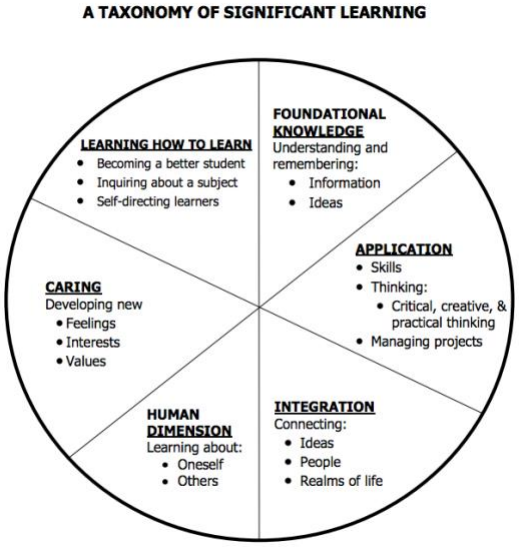
As I worked to complete my own college degree, these challenges arose for me course-after-course, year-after-year. I found these recurring themes to be the most difficult part of my college experience and I spent a ton of time thinking about how to overcome these difficulties in my own life as a student. Using what I learned, I want to encourage and help you develop strategies to overcome these challenges in your education. To do so, I provide activities to help you develop and refine a suite of learning skills that are quite useful in strategically addressing the challenges listed above. I provide these activities for no charge on my www.appliedlinearalgebra.com website at http://www.appliedlinearalgebra.com/resources/study-skills-playlists/conquering-college. I encourage you to work through these study skills activities and refine your abilities as a student.

Here is a mantra you can recite to yourself each day throughout the quarter as you struggle to learn in this class:

"Today, I promise to do my very best in this course. I commit myself to staying healthy and to giving my best effort to improving my learning processes. I will stay engaged with this material throughout the quarter. I know that by combining my best effort with effective study strategies, I can learn this material and achieve my goals."

WHAT ARE THE MAJOR CATEGORIES OF SIGNIFICANT LEARNING EXPERIENCES?

There are a variety of different types of learning that contribute to significant learning experiences in this class. Below is a synopsis of the most important categories of learning that we will focus on together.



Caring: Sometimes what we learn may change the degree to which we care about something. This may arise in new feelings, interests, or values. Any of these changes might indicate that we now care about something to a greater degree or in a different way than we did before the class started. When we care about what we are studying, we are much more likely to put the energy we need for learning and to making it part of our life. Without this care and excitement, we will not be able to create significant learning over time.

Learning how to learn: In the course of our studies, we can learn new techniques to enhance our capacity to learn effectively and efficiently. We might learn how to be a better student, how to become a self-directed learner, or how to engage in a particular kind of inquiry (like applied mathematical modeling or the scientific method). All of these constitute important forms of learning how to learn. This kind of study empowers us to continue learning in the future and to more effectively navigate the U.S. higher education system and many other systems in our society.

Foundational Knowledge: At the base of most kinds of learning is the need for us to know something. Knowing refers to our ability to understand and remember specific information and ideas. In this class, it will be important that you have some valid basic knowledge of the course content. You will also need to know something about how the theorems we study are used in applied mathematical modeling. Foundational knowledge provides basic understanding that is necessary for other kinds of learning.

Application: In addition to picking up facts and ideas, we also learn how to engage in new kinds of actions. Learning how to engage in various forms of thinking (critical, creative, practical, logical, etc.) is an important form of application learning. This category includes developing skills or learning to manage complex projects. Application learning make other kinds of learning more useful.

Integration: When we're able to see and understand the connections between different concepts and ideas, this is a very important kind of learning. Sometimes we make connections between specific ideas, between individual courses you have taken, between individual courses and larger fields of study, or between different realms in our life (e.g. between our school and employment or between our school and personal lives). The act of making new connections gives us a new form of intellectual power.

Human dimension: When we learn something important about ourselves, we might function and interact more effectively with the world around us. In this form of learning, we discover personal and social implications of what we have learned. What we learn or the way in which we learn sometimes gives us a new understanding about ourselves (self-image), a new vision of what we want to become (self-ideal), or greater confidence that we can do something important. We can also acquire a better understanding of other people including how and why others act the way they do or how we can interact more effectively with others. This kind of learning helps give us a sense of the human significance of what we are learning.

WHICH OF THESE CATEGORIES OF SIGNIFICANT LEARNING IS MOST IMPORTANT?

When considering all 6 categories of significant learning, I believe that **learning how to learn is by far the most important aspect of your time in this course**. If you are lucky enough to create a career in which you rely heavily on theory from this class, you will likely need to learn a bunch of ideas outside the content of this course to effectively solve problems using this theory. In fact, if you plan on being paid to do knowledge work, your future career will be filled with continual learning and reflection. This reality is part of the information age. Only as a lifelong learner will you be able to keep up with our society's explosive growth of knowledge, develop new skills that you may need to accomplish your goals, and explore new directions in your career. The need to consistently reflect on your circumstances, retool your professional credentials, and develop new skill sets is already the norm for our generation and future generations to follow. The ability to learn effectively and to monitor your learning habits is fundamentally important as a basic economic survival skill. With this in mind, I ask you to focus heavily on the study skills activities that I designed to help you critically reflect on your learning. Many of the suggested exercises I will assign you provide guidance on how you can develop professional learning skills in the U.S. higher education system while strategically navigating your degree pathway. My hope is that by having you complete these study skills activities, I will help you develop yourself as an intentional, independent, self-regulated learner.

WHAT IS SELF-REGULATED LEARNING?

Self-regulated learning includes the monitoring and management of all cognitive processes that we use to learn. In order to effectively manage our learning processes, we need to be awareness of and in control over our emotions, motivations, behavior, and the environment we use to learn. With this in mind, there are two major components of self-regulated learning that we develop together:

Our Behavior: Self-regulated learners intentionally create systems of thought and action that

i. Develop self-discipline, self control, and self confidence
ii. Enable effective and efficient effort while learning
iii. Utilize strategic time management to accomplish learning goals
iv. Include help seeking habits to get support from more advanced learners

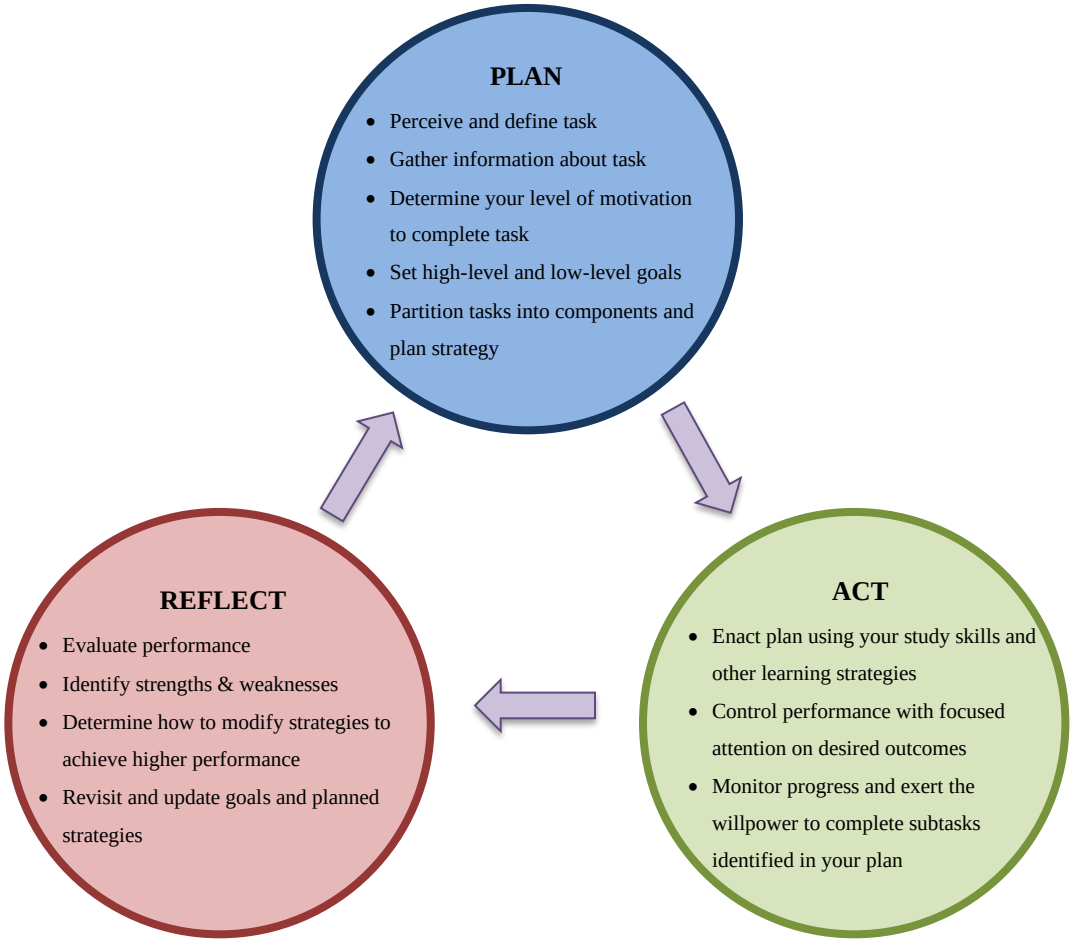
Our Environment: Self-regulated learners design a learning environment in that

i. Provides optimal sensory inputs for deep thought, including physical study space(s) with appropriate temperature, background sounds, lighting, and physical layout.
ii. Enables effective task management when working on aspects of a project or when managing different projects with overlapping due dates.
iii. Encompasses a value-based use of technology aligned with your goals.

As self-regulated learners, we manage the entire spectrum of our learning experience by iteratively engaging in plan-act-reflect cycles, as shown in the diagram below.

WHAT ARE THE THREE PHASES OF SELF-REGULATED LEARNING?

One useful way visualize the multiple dimensions of self-regulated learning is through the plan-act-reflect cycle illustrated below:

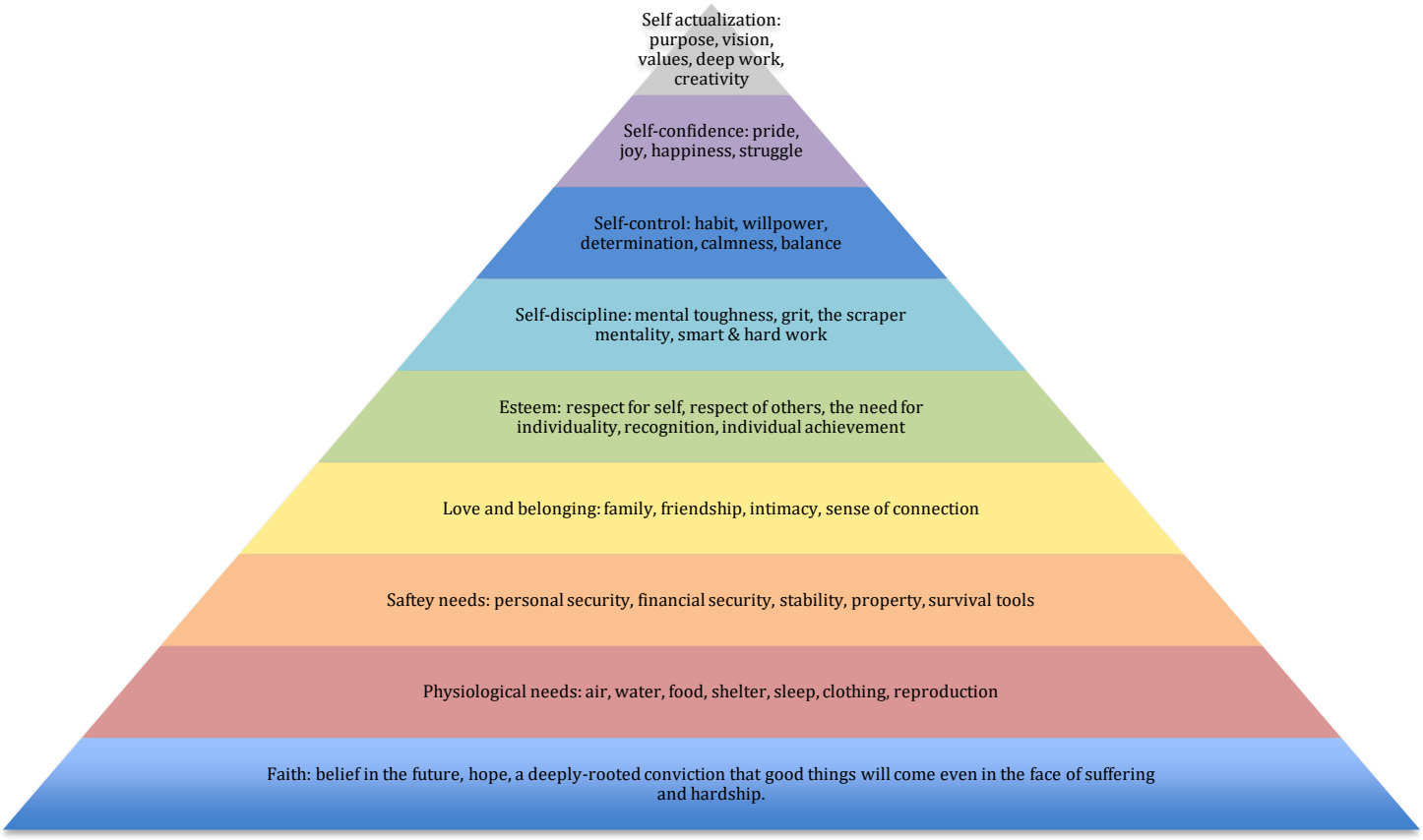


WHAT KIND OF PRIVELDGES DO I NEED IN MY LIFE TO BECOME A SELF-REGULATED LEARNER?

The journey to become a self-regulated learner assumes many privileges in your personal and professional life. The pyramid below is an adaptation of Maslow's Hierarchy of needs specifically designed to illustrate the process self-regulated learning as a hierarchal pyramid. The top four levels of this pyramid are focused on the iterative process of refining self-regulated learning skill.

I urge you to pay special attention to the bottom layers of this pyramid. One of the underappreciated secrets of the art of deep and strategic study is that basic psychological needs are necessary prerequisites for sustained learning. If we live in an environment in which we habitually lack one of these needs, our journey to develop ourselves as self-regulated learners becomes nearly impossible. This is an often unspoken yet crucial truth in college life.

Thus, when prioritizing your to-do list, I encourage you to focus on building systems to address your lower-order needs before you make a full commitment to the top four layers of this pyramid. This may imply that you need to spend time and energy honestly assessing your current circumstances or building a network of support to address challenges in your personal life. I believe deeply that your physical, emotional, and mental well-being take precedence over academic performance. I also believe that working through challenges in your personal life takes time, energy, and grit. In this class, let's start this process as a part of your focus on learning.

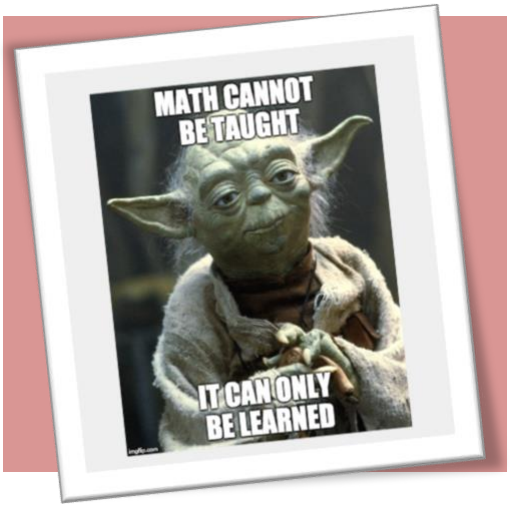


BUT ISN'T THIS CLASS SUPPOSED TO BE ABOUT MATH?

I believe that if we can develop powerful learning processes and combine these with a strong sense of purpose, we will be able to learn any topics in mathematics that we are interested in studying. In particular, I find that becoming a self-regulated learner is an important precursor to successfully mastering mathematical theory in a way that supports your future career goals. Thus, I want to focus your energy on developing yourself as a self-regulated learner. However, I recognize that we are formally tasked with learning the mathematical definitions, theorems, examples, and ideas that make up this course. In other words, we will be developing your learning skills in the context of building foundational knowledge, integrating this knowledge with other ideas you've studied, and applying this knowledge to various aspects of your life. With this in mind, let's discuss some very useful ways to think about the study of mathematical ideas.

HOW CAN YOU BUILD FOUNDATIONAL KNOWLEDGE IN MATHEMATICS?

Remember that foundational knowledge refers to your ability to understand and remember specific information and ideas. Because foundational knowledge exists in your brain, the only way to build foundational knowledge is through experience and reflection. In fact, it is impossible for me (or any instructor) to teach you any particular piece of foundational knowledge within mathematics.



Instead, the only way for you to form foundational knowledge about mathematics is to creating your own mental map of each idea we study in this class. This involves analyzing each idea that we study and constructing a robust mental schema in your own mind to encode each idea. Such a process is iterative and challenging. Encoding each idea in your mind requires dedicated deep work over many study sessions spanning multiple days of your life.

If you do this process well, your mental schema will support deep understanding of each idea and your ability to recall the various aspects of the idea when you need them. In order to understand how this process works, we need some useful terminology to discuss the various aspects of building foundational knowledge in mathematics.

WHAT IS A CONCEPT DEFINITION?

Many people created most of the formal mathematics you study in this class over a long period of time. Multivariable calculus has been around for centuries and has been used to solve technical problems by many generations of scientific thinkers. Throughout this history, mathematicians and practitioners have refined the formal language used to encode the various ideas that you study in this class.

Throughout this history, the approaches to this theory that seemed to yield optimal results for young learners were repeated, emulated, and developed over generations. Similarly, less helpful language and approaches were usually abandoned. One of the major advantages that you have as a young learner of this theory is that you have access to a well-refined and coherent set of ideas that compose this class.

We will refer to a *concept definition* as a formal, logically coherent, verbal description including technical jargon that appears in a textbook or is provided to you by an instructor. The term concept definition may refer to a definition of a technical term. However it can also refer to theorem statements, descriptions of procedures, problem statements and associated solutions, or even statements of exercises to be completed by you, the student.

Each concept definition that we study in this class describes a set of underlying ideas in a succinct, non-circular manner. At the bachelors and masters degree level, experts provide to you almost every concept definition you will study[1]. The major challenge of the information age is not to gain access to the various concept definitions that compose a particular class. Instead, your task will be to fully analyze, digest, understand, and encode the many concept definitions that you must study to successfully complete a class. Thus, creating foundational knowledge in mathematics requires taking concept definitions created by experts and building mental representations of these ideas in your own mind. We will refer to such mental representations as *concept images.*

[1] Ph.D. candidates study unsolved problems in mathematics. In many cases, Ph.D. thesis and future research papers introduce new concept definitions associated with various components of unsolved problems.

WHAT IS A CONCEPT IMAGE?

A *concept image* is a mental scheme or neural network that exists in your mind and consists of

(A) everything that you have associated with a particular concept in your mind and

(B) what you are able to do with regards to that concept.

A concept image might include analogies that you have constructed to better understand an idea or various relationships between the specific idea you are studying and other concepts, examples, or nonexamples relating to this idea. Concept images may also include ways of solving problems, nontechnical verbal descriptions, or visual representations of the idea.

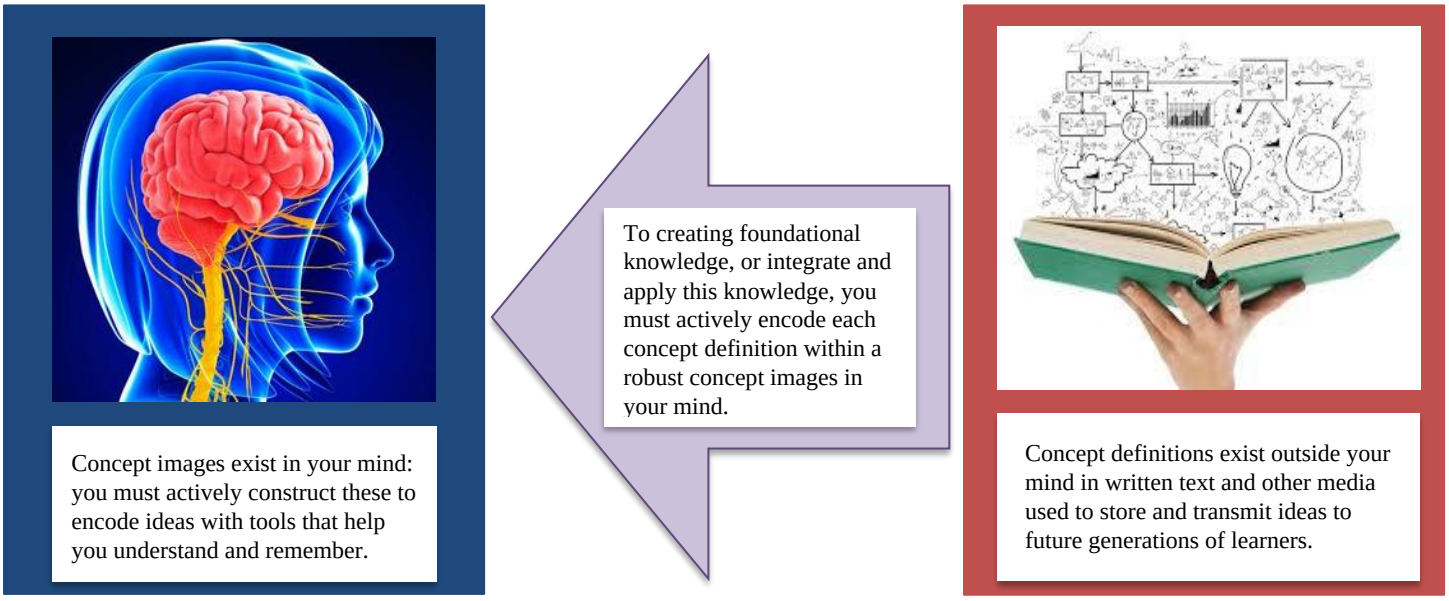
Note that a concept image does not necessarily include spatial visualizations or geometric interpretations of an idea as the term "image" might suggest. In fact, it is quite possible to have an effective concept image associated with a mathematical idea that does not include any spatial or visual diagram.

Unlike concept definitions that are given to you by others, you must actively work to construct concept images. When you construct an effective concept image of a certain mathematical idea, you "understand" that idea in its full glory. When you take an exam in a mathematics course, your instructors are attempting to measure the strength of your concept images associated with the various topics you've studied in that course.

Indeed, one of the most important indicators for understanding a concept is the ability to solve problems related to the concept. When solving a problem, you must know *both* what to do and why you need to do this. Moreover, you should be able to discuss, in detail, the interrelations between the problem you are solving and the core ideas you are using to generate your solution(s).

This ability to solve problems is nuanced and has many levels of proficiency. The interrelated components of your ability to problem solve using a particular concept image that you have constructed include:

A. the ability to *remember*, not just memorize, the concept image
B. the ability to *communicate* nuanced ideas in your own words completely and accurately
C. the ability to *think in general terms* and identify the core ideas behind a concept image even if these ideas are abstracted away from specific examples that rely on that concept image.
D. the ability to *connect* ideas and *integrate* new foundational knowledge with previously constructed foundational knowledge. In order to construct an effective concept image, you will need to develop each of these abilities relative to the mathematical idea you are studying.



WHAT ARE CATEGORIES OF THOUGHT YOU CAN USE TO DEVELOP A CONCEPT IMAGE?

When constructing a concept image, I can think of at least seven different categories of ideas that provide unique paradigms through which to view each mathematical concept definition that we study.

***Verbal descriptions**:*
Formal concept definitions are written in highly technical jargon that may seem foreign upon first examination. When creating verbal descriptions to encode a concept definition, we must complete two related but independent tasks. First, we must be able to summarize the concept definition in our own words entirely and completely. This process requires us to decode each technical word or phrase we encounter, create or access mental maps of each underlying idea, encode these ideas in words that make sense to us, and synthesize a description of the concept definition that is entirely in our own words. In doing so, we must be sure to address possible inaccuracies in with our encoding and to ensure that we have not lost any important information. The process of encoding a concept definition in our own language fully and completely is by far the hardest and most important part of creating a verbal description of a concept definition. However, if we plan on being a part of a community of working professionals who use these ideas, it is also important that we learn to use the technical jargon associated with this concept definition correctly. In other words, the second task of creating a verbal description is to learn how to use each technical term correctly and to encode our understanding in the language of the field.

Visual description:
Many concept definitions can be effectively encoded using meaningful visuals. Such visuals include but are not limited to graphs, images, diagrams, or maps that help to encode and interpret an idea geometrically or visually. Often when constructing a verbal description, it is useful to create an associated visual description with labels, comments, and explicit connections between the words we choose and a corresponding diagram we create.

Symbolic descriptions:
Concept definitions in mathematics are also encoded using symbols and notation. There are two types of symbolic representations that might be helpful to us as we refine our concept images. First, there is notation that others have created for us and that we decide to adopt. When studying mathematics in college, it is often wise to use the standard notation that our professor introduces. As an expert in the field, our instructor might have made many choices about notation that will help us avoid confusion without communicating to us why she made these choices. Unless we have some very compelling reason not to, we might choose to adopt the notation our professor uses and ask for clarifications about why our teacher made these choices for notation during office hours. On the other hand, there are some instances that we will want to create notation (variables, symbols, operations, etc.) for ourselves. In this case, we need to be careful to communicate the implied meaning of our notation to any person that grades our work.

Algorithmic descriptions for pen-and-paper analysis:
Many concept definitions in mathematics are related to specific algorithmic or procedural processes to find a specific result or execute a special calculation. In order to fortify a given concept image, we will find it very useful to analyze algorithms and procedures that relate to a specific set of concept definitions.

Logical descriptions:
Concept definitions in mathematics are often encoded using formal logical structures such as conditional statements, conditional statements, universal quantifiers, or existential quantifiers. The process of creating robust concept images often involves a detailed analysis of the logical structures implicitly stated in the concept definition.

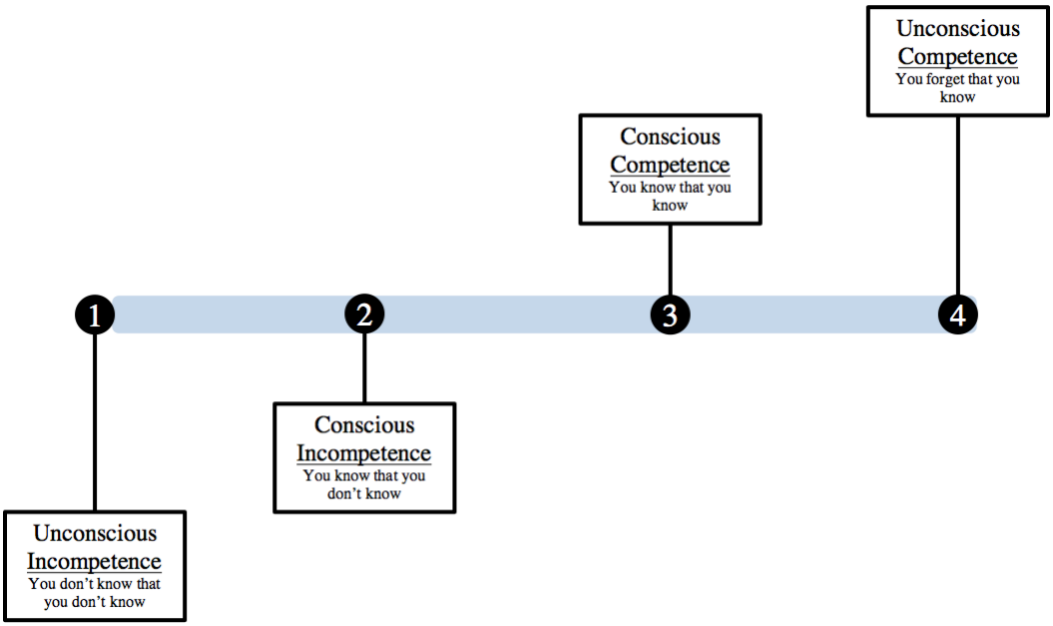
Modeling descriptions:
One of the most beautiful and frustrating dimensions of mathematical theory is that formal concept definitions are often abstracted away from the most powerful applications in which they arise. When encoding a concept definition, we can create nuanced meaning and deep understanding by identifying the idea with applied modeling scenarios in which the idea arises. This type of identification and integration empowers us to make connections between specific mathematical objects and lived experiences that we observe in our daily life. By doing so, we can start to make connections between our non-math classes, our career interests, and the formal theory we learn in our math classes. This type of encoding can lead to much higher levels of motivation and an "intuitive" grasp of a concept definition within a framework that interests us. Such knowledge can lead to concept images that are very "sticky" and form a bridge between our formal education, our social life, and our future career plans. This knowledge can also help us get paid.

Algorithmic descriptions for digital computation:
A professional applied mathematician living in the 21st century who expects to be paid to solve problems using mathematics not only develops concept images with knowledge from the first six categories described above, but she also build special knowledge of how to use digital computers to solve applied problems. This often requires specialized knowledge of computation, data encodings, and algorithms that are specifically designed to converge on finite computation machines.

THE FOUR STAGES OF MASTERY: DEVELOPING CONCEPT IMAGES

Notice that on pages 10 – 12 of the syllabus, we've developed a very specific description of what it means to learn foundational knowledge in this math class. In particular, for each concept definition that we study, we say we learn this knowledge by developing our associated concept image. Deep learning, then, is evidenced by mastery of the concept. I will measure such learning by assessing the strength of your concept images.

With this in mind, I encourage you to be aware that each time you study a new concept definition, you begin your process of developing mastery. In an academic context, mastery refers to the attainment of a high degree of competence within a particular area. When developing concept images in this class, we will focus on a subset of the theorems, formulas, and techniques articulated in the course outline of record. To develop mastery over a specific concept definition, we need to acquire component skills, practice integrating these skills, recognize when to apply the skills we've built, and learn how to apply the skills in novel contexts. I will encourage you to think about each learning experience as part of a four-stage process of developing mastery, as depicted in the diagram below.



Stage 1- Unconscious Incompetence: In this first stage of developing mastery, the learner has not yet developed skills in a particular domain and does not have sufficient knowledge to recognize what they need to learn. Most learners who are studying a new idea for the first time start in this stage.

Stages 2- Conscious Incompetence: In the second stage of building competency with a new concept, the learner becomes increasingly aware of what she does not know and what she needs to learn. In this stage, the learn has just begun to construct the relevant concept image in her brain

Stage 3- Conscious Competence: In this third stage of mastery, the learner has considerable competence in the new domain. The learner must still think and act deliberately and consciously. However, she is now fully aware of almost all important aspects of the new knowledge she's studied and she has made meaningful connections between these new ideas and her own prior knowledge.

Stage 4- Unconscious Competence: At this fourth and final stage, the learner exercises the skills and knowledge she has acquired so automatically and instinctively that she is no longer consciously aware of what she knows or does. She is able to blend the ideas that she has mastered with many other ideas effortlessly and recall pertinent facts quickly.

For each idea we study, we'll imagine ourselves traveling on an adventure. At the start of this journey when we are studying an idea that we've never seen before, we are novices. As we gain familiarity with the idea and begin to make connections between the new knowledge we study and other concepts we know, we move into the intermediate stages of mastery that represent the middle stages of our journey. After many hours of study spread across weeks of the quarter, we may be lucky enough to transcend into the first stages of expert knowledge.

A FOCUS ON TEACHING

WHAT IS MY TEACHING PHILOSOPHY?

Now that we have discussed the definition of learning, the various aspects of significant learning, the ideas behind self-regulated learning, and the important aspects for building foundational knowledge, I'd like to share my teaching philosophy with you. I define my main responsibility as your mathematics instructor as supporting you in create significant learning experiences in this course. I believe that I am most effective as a math teacher when I can:

A. Facilitate a learning environment in which you, my student, are in charge of your own learning processes and in which you and I share responsibility for and control over your learning.
B. Deliver course content using techniques designed to maximize understanding and mastery.
C. Create learning activities that are based on research results from the learning science.
C. Provide ample support and targeted feedback to you.
E. Demonstrate a high level of enthusiasm for course content.

This syllabus is written to give you more insight into how I plan to achieve points A – E. I will return to these ideas throughout the course. I work hard to design each aspect of the course to map back to one of these five pillars of my teaching philosophy. This is how I define my role as an instructor and how I measure my performance in the classroom.

WHAT ARE MY EXPECTATIONS OF MYSELF AS AN INSTRUCTOR IN THIS CLASS?

Significant learning is as challenging as it is satisfying. In this class, I will guide you to create, develop, and refine a number of effective study techniques. I believe that professional teacher-student relationships are sacred and involved shared responsibility. Thus, I want to communicate the expectations I have for my own behavior in our classroom. Below I outline my expectations for my behavior during our time together.

TABLE 1: MY EXPECTATIONS FOR MYSELF AS AN INSTRUCTOR

Expectations for Instructor Behavior to be Emulated:	Expectations for Instructor Behavior to be Avoided:
A. Make a commitment to maintain a positive attitude and strive to give my best effort in this class	A. Avoid assigning work that results in mindless repetition and passive learning.
B. Be active, enthusiastic, and professional about facilitating student learning.	B. Avoid focusing only on math content at the expense of encouraging students to develop learning skills.
C. Be open to learning from each of my students.	C. Avoid creating policies that hinder your learning.
D. Be open to student questions.	D. Avoid fixed mindset judgments about your ability.
E. Be approachable in class and make it easy for students to find times ask questions and talk about learning needs.	E. Avoid the belief that my mastery of this material implies that this content is easy.
F. Listen carefully and respect students' ideas.	
G. Empathize with my students, be open to student feedback, and respond swiftly and effectively to student concerns.	F. Avoid making judgments about students' lives.
H. Communicate clear expectations to students about in-class assessments and assignments	G. Avoid pop-quizzes and assessments that require material not directly contained in our lecture notes.
I. Be in-class at least one minute before and after every scheduled in-class meeting.	
J. Be prepared for class.	
K. Make a concerted effort to accommodate students' learning needs.	H. Avoid the use of email to communication as much as possible.
L. Protect the academic integrity of this class.	

I welcome your feedback and I know I can learn something new by understanding your ideas and experiences.

CAMPUS RESOURCES AND OTHER INFORMATION

HOW DRC ACCOMODATIONS WORK?

We at Foothill College view students with different learning needs as an important part of our campus community and we are committed to providing excellent learning opportunities for all students. Foothill College's Disability Resource Center (DRC) is the campus office that collaborates with students who have documented learning disabilities. In doing so, the DRC provides and arranges reasonable accommodations for such students.

If you have, or think you have any attention, learning, chronic health, mental health, sensory, or physical disability, please contact the DRC to discuss what our campus can do to arrange reasonable accommodations that will help you achieve your learning goals. To contact DRC, you may:

- Visit the DRC in Building 5400 of Student Resource Center during the following hours:
  - Monday & Tuesdays: 8:00am – 7:00pm
  - Wednesdays & Thursdays: 8:00am – 5:00pm
  - Friday: from 8:00am – 3:00pm
- Email DRC at drc@foothill.edu
- Call DRC at (650) 949-7017 to make an appointment.
- Visit the DRC website at http://www.foothill.edu/drc/

If you are registered with DRC and have accommodations set by a DRC counselor, please use Clockwork to send me (your instructor) your accommodation letter. Please also privately contact me early in the quarter to discuss your needs and review how your accommodations will be applied.

Please be aware that if you are a student who needs accommodated test proctoring, you must meet appointment booking deadlines at the Testing Center, which are as follows:

- In-Class Exams must be booked at least three (3) business days/weekdays in advance of the instructor approved exam date/time.
- Finals exams must be scheduled seven (7) business days/weekdays in advance of the instructor approved exam date/time.
- Failure to meet appointment booking deadlines will result in the forfeit of testing accommodations. In this case, you will be required to take your exam in class.
- Please contact the DRC if you need help accessing your Clockwork account via MyPortal.

Foothill's DRC strives to provide accommodations in a reasonable and timely manner. Please be aware that some accommodations may take additional time to arrange. We encourage you to work with the DRC and your instructor as early in the quarter as possible so that we may ensure that your learning experience is accessible and successful.

WHAT OTHER INFORMATION MIGHT BE HELPFUL?

Religious Holidays: If you have a religious holiday or observance during the quarter that conflict with class, please speak with me in person by the end of the first week of class.

Disasters: If a natural disaster, or any other occurrence, closes the campus, I will make adjustments to any existing calendars and assignments at our next class meeting when the campus reopens. If the campus closing interferes with an in-class exam it will be given at the next class meeting. If the natural disaster interferes with the final exam, it will be canceled, and your final grade will be based on your existing scores.

Psych Services: Life at college can get very complicated. You may sometimes feel overwhelmed, lost, experience stress, anxiety or depression, or struggle with relationship difficulties. Many of these issues are very common and can be effectively addressed with a little help. Foothill College's Psychological Services & Personal Counseling helps students cope with difficult emotions and life stressors. Psychological Services is staffed by experienced, professional psychologists and counselors, who are attuned to the needs of college students. The services are FREE and completely confidential. Find out more at https://foothill.edu/psychservices/

Emergency Info: I value your safety and the safety of all Foothill students and employees. I encourage you to be prepared for an emergency. To do so, please:

- Keep your permanent address and emergency contact info current in MyPortal.
- Sign-up to receive Foothill College emergency text alerts in MyPortal.
- Know the safe evacuation routes from each of your classrooms. Emergency evacuation routes are posted in all classrooms.
- Listen for and follow instructions from Foothill College or other designated authorities. Within the classroom, follow your instructor's instructions.
- Pre-program your cell phone with the emergency phone number for the Foothill-DeAnza Police Department: (408) 924-8000. This will ensure a faster response time
- Report suspicious activities and objects immediately to the FHDA Police.

Final Thoughts: I believe that you can succeed in this course. I do NOT believe there is such a thing as a math person. Instead, I believe that:

- When you learn how to solve new problems, you are growing your math brain.
- If you catch yourself saying "I'm not a math person' just add the word 'yet' to the end of the sentence.
- The feeling of math being hard is the feeling of your brain growing.
- The point of all the work you do in this class isn't to understand everything right away. The point is to grow your understanding, step-by-step.

Please be patient with yourself if you do not immediately see how to solve a problem. Try each assigned problem, make lots of mistakes, ask lots of questions and learn from your mistakes. Most of all, try to have fun learning and expanding the frontiers of your skills.