Name : ____________________

Conquering College, Lab 3 : Prepare for Flipped Learning
by Jeff Anderson

We have a national need to improve the quality of STEM undergraduate education "to ensure the economic strength, national security, global competitiveness, environment, and health of the United States" [NASEM2016, p. 7]. As is outlined in the 2012 Report for the President's Council of Advisors on Science and Technology (PCAST), "fewer than 40 percent of students who enter college intending to major in a STEM field complete college with a STEM degree" [PCAST2012, p. 7]. That PCAST report argues that to meet the nation's future needs, we must increase the number of STEM majors that we recruit and retain. Moreover, that document suggests that we should focus on improving STEM courses taken in the first two years of college and put a special priority on utilizing empirically validated teaching strategies that emphasize active learning and student engagement. In this class, we work together as a community to implement research-based teaching strategies to empower you to take ownership over your college education and your STEM learning journey. I hope we can work as a team to inspire every learner in this class to persist in STEM for as long as you want and to build your excitement about your future academic and career endeavors.

Address our need for STEM majors using innovative curriculum

Most introductory STEM classes are taught using lectures in which the instructor delivers long, technical monologues and provides little opportunity for student engagement. Extensive research indicates that to increase the number of students who receive STEM degrees, college teachers should "abandon traditional lecturing in favor of active learnin" [Freeman2014]. Indeed, 90% of students who leave STEM majors cite "poor teaching" and "problems with instructor pedagogy" as a powerful concern that contributes to their desire to leave their field [Seymour2019, p. 8]. Students also indicate that they yearn for and often do not find illustrations of how course content can be applied to authentic problems related to their academic and career interests. The lack of real-world examples and relevant modeling activities in introductory classes contributes to students' decisions to abandon STEM majors [Seymour2019, p. 10]. To address these issues, we need to create learning experiences that inspire students to feel excited about STEM disciplines. This is particularly important in introductory mathematics classes that set a foundation for more advanced learning. We must re-imagine our introductory mathematics curriculum to include active learning activities where learners can develop and analyze real-world mathematical models that inspire students to believe that what they are studying is useful, meaningful, and powerful.

Research indicates that we can increase student persistence by implementing three interventions to change student experiences in introductory STEM courses. The first relates to designing teaching routines that intellectually engage students in meaningful learning activities. Replacing traditional lectures with active learning practices improves student learning, increases retention rates in STEM classes, and reduces achievement gaps within diverse student populations [McConnell2017]. The key to active learning is to engage students in "doing things and thinking about what they are doing" [Bonwell1991, p. 2]. Such active learning tasks include any activities in which every student engages in critical thinking, creative problem solving, attentive observation, meta-cognitive reflection, meaning making, and relationship building in the context of shared learning [Fink2013, pp. 115 - 137].

The second intervention involves creating relationship-rich educational experiences for students. Decades of research suggests that student-faculty, peer-to-peer, and student-staff relationships are essential factors that lead to deeper learning, a stronger sense of belonging, and higher achievement in college [CITE]. Indeed, "students' interactions with peers, faculty, and staff positively influence the breadth and depth of student learning, retention and graduation rates, and a wide range of other outcomes, including critical thinking, identity development, communication skills, and leadership abilities" [Felton2020, pp. 5]. Developing meaningful relationships with peers and instructors is especially important for minority, female, and first-generation students [Kezar2014]. Students who enjoy authentic relationships and identify with a community of STEM professionals persist longer and show reduce departure rates from STEM fields [Espinosa2011]. Lectures provide none of these benefits. Indeed, students who sit through lectures do not develop meaningful relationships with either their teacher or their peers since the in-class experience is dominated by the lecturer. Lectures do not help student learn how to prioritize question and answer sessions, do not guide students through active problem-solving sessions, nor do they provide students support for building meaningful academic relationships. To counteract the harms of lecture, we must re-design curricula and classroom activities that emphasize student interactions with faculty and peers as part of their in-class learning activities.

The third intervention that affects student persistence involves an explicit focus on tapping into students? intrinsic motivation for mastering STEM disciplines. A powerful source of intrinsic motivation is interest which consists of two distinct experiences including "an individual's momentary experience of being captivated by an object as well as more lasting feelings that the object is enjoyable and worth further exploration" [Harackiewicz2016]. Research shows that when students feel interested in learning, they spend more time studying, learn at a deeper level, persist longer on learning tasks, and get better grades in their classes [Silvia2008]. Interest also plays a central role in the growth of expertise and knowledge development [Sansone2005]. However, many introductory mathematics classes and textbooks focus heavily on abstract theory and algorithmic tasks that are removed from contexts that students find interesting. Textbooks that do provide applications often relegate such discussions to short essay descriptions or brief exercises. In both cases, the curriculum focuses on simplified models of ideal situations that are far removed from students' lived experiences. Students that engage with these types of learning materials likely have no opportunity to collect realistic data, no chance to discover connections with the material world, and may find it impossible to discover how the math they learn is applicable to solving problems they care about.

In recognition of the urgent need for drastic changes in mathematics curricula and teaching practices, a wide range of professional societies and mathematics organizations have produced studies, reports, and guidelines offering specific recommendations for improving undergraduate mathematical sciences programs. The Mathematical Association of America (MAA) argues that "the status quo is unacceptable" and recommends that teachers should update introductory mathematics curricula to focus on active learning, use evidence-based teaching practices, and establish stronger interdisciplinary learning tasks that ignite students? interests [MAAVision2015]. The MAA's 2015 Curriculum Guide to Majors in the Mathematical Sciences suggests that "students should learn to link applications and theory" [CUPM2015]. Those guidelines also recommend that "students should develop mathematical independence and experience open-ended inquiry." The Society for Industrial and Applied Mathematics (SIAM) along with the Consortium for Mathematics and Its Applications (COMAP) provide convincing arguments for incorporating real-world mathematical modeling activities into classroom learning in their Guidelines for Assessment and Instruction in Mathematical Modeling report. These guidelines emphasize that mathematical modeling "should be taught at every stage of a student's mathematical education" [GAIMME2019]. They go onto suggest that mathematical modeling should "be used to motivate curricular requirements" while highlighting "the importance and relevance of mathematics in answering" questions that students care about. In a related 2013 report, the National Research Council (NRC) recommended that introductory college mathematics courses should provide student with opportunities to make explicit connections between mathematics and other disciplines [NRC2013, p. 2 - 3]. That NRC document argues that mathematical scientists must be "knowledgeable across a broad range of disciplines" and "understand the role of the mathematical sciences in the wider world of science, engineering, medicine, defense, and business" [NRC2013, p. 3]. Similar guidance is offered by the Transforming Post-Secondary Education in Mathematics (TPSEMath) project. That effort calls for increased inclusion of modeling in college math classes that "demonstrate ways to connect the mathematics studied to students intended majors" while also offering "interesting ways to deliver instruction and engage students" [TPSEMath2014, p. 5].

As is evident in work highlighted above, there are powerful national interests calling for curricular and pedagogical changes in introductory college mathematical classes. To attract and retain STEM students, we must find creative and innovative ways to enrich introductory mathematics courses using interdisciplinary modeling activities that peak students? interest while demonstrating that mathematics is a powerful tool to solve real-world problems. In this class, we are going to work together to engage you in meaningful learning tasks, to invite you to build relationships with our classmates and me, and to help you ignite your interest in math and meta-learning.

1. **Prepare for Flipped Learning**

   In this activity, you are going to continue to develop and refine your understanding of what learning is and how it works. The goal of this activity is to help you set yourself up to think about how our flipped learning classroom will work. This is a crucial first step in having you think about your general approach to the learning portfolio you're going to create in this class.

A. In this first activity, you're going to find spaces to engage in deep learning and also create routines to help you protect yourself against the harms of traditional lectures.

- ☐ (1.A.i) Read Jeff's blog post Find deep learning spaces
- ☐ (1.A.ii) Fill out questions 1 - 6 on pages 1 - 3 of the following document:

  Find Deep Learning Spaces Worksheet (.docx) .
- ☐ (1.A.iii) Read the Flipped Learning FAQs document
- ☐ (1.A.iv) Fill out questions 1 - 6 on pages 1 - 3 of the following document:

  Flipped Learning FAQs Worksheet (.docx) .
- ☐ (1.A.v) Read Jeff's blog post Create Lecture Notes Systems.
- ☐ (1.A.vi) Fill out questions 1 - 6 on pages 1 - 3 of the following document:

  Create Lecture Notes Systems Worksheet (.docx) .

B. Let's continue to develop and refine your model for how learning works and think about how you will build your deep learning skills in this flipped classroom environment. In this case, you're going to hear student voices from Jeff's past classes. You'll also start to craft your vision for your learning portfolio.

- ☐ (1.B.i) Watch Jeff's Math 2B Interview with Maria Mihaila.
- ☐ (1.B.ii) Read Jeff's blog post UNgrading in action: Lessons from spring 2022.
- ☐ (1.B.iii) Fill out questions 1 - 6 on pages 1 - 3 of the following document:

  First brainstorm for your learning portfolio process worksheet (.docx) .

What you should include in your learning portfolio to show you've completed this activity:

- ☐ Your work on the Find Deep Learning Spaces Worksheet (.docx) .
- ☐ Your work on the Flipped Learning FAQs Worksheet (.docx) .
- ☐ Your work on the Create Lecture Notes Systems Worksheet (.docx) .
- ☐ Your work on the First brainstorm for your learning portfolio process worksheet (.docx) .
- ☐ Anything else you'd like to share to show evidence of your learning on this activity

---

What are the next steps?

Take a look at the course calendars for this class. Between now and our next class, begin to create your learning portfolio for the first bit of content outlined on the calendar you plan to follow. We will be iteratively improving your approach to learning over the quarter so don't worry about this being perfect. Give it your best shot and bring what you have with you to our next class.