# *Developing Discipline-Related Teaching Strategies*

*Competency Information*

**Competency Description**

Teaching a student's specific discipline poses numerous challenges for instructors. The primary challenge is that no universal teaching strategy can effectively impart learning material to all students. Instead, instructors must utilize multiple teaching strategies that cater to different learning styles. Most of these teaching strategies in the STEM discipline implement active learning approaches (i.e., Modeling instruction, Problem-Based Learning, Argument-Driven Inquiry) designed to meet specific learning objectives. However, instructors must be careful when implementing these active learning approaches. Often, instructors focus on developing fun/enjoyable active-learning activities and neglect how these activities will lead to any understanding in our students. Effective teaching strategies should promote student understanding by providing a clear purpose and explicit performance goals.

**Competency Development**

To enhance my proficiency in discipline-related teaching strategies, I enrolled in Teaching College Science (ISE870; Spring 2022). During the course, I had multiple opportunities to evaluate and challenge current pedagogical issues in science education. In addition, I was introduced to various theories and practices in postsecondary teaching, including student-centered pedagogical practices, a range of assessment strategies, and curriculum and lesson design fundamentals. Specific to the development of this competency, I engaged in…

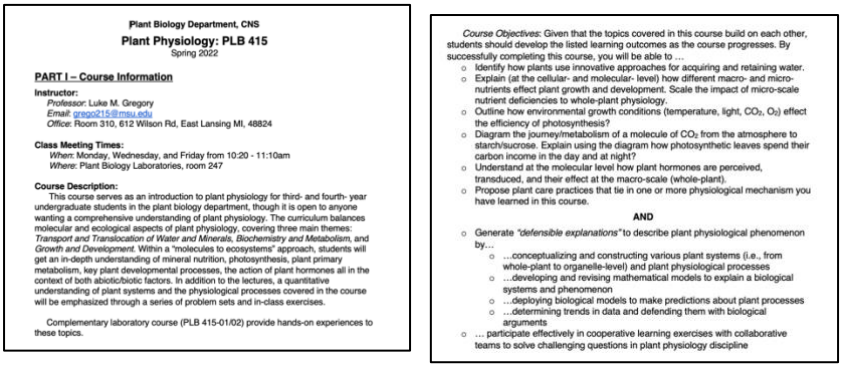
1) *Syllabus Design*: I developed a curriculum for an undergraduate Plant Physiology course that showcased formative-heavy teaching (i.e., whiteboarding, student feedback, Think-Pair-Share), quantitative reasoning exercises using real-world problem sets, and cooperative learning groups.
2) *Lesson Plan Design & Micro-Lecture:* I developed a student-centered lesson for a photosynthesis unit that would be a part of a broader undergraduate plant physiology course. I implemented Backwards Design when constructing this unit to align learning objectives to the performative task.

Additionally, I was selected to be a FAST fellow in 2023-2024. During this year-long fellowship, I received pedagogic mentorship, read educational literature, and engaged in group discussions with my FAST cohort and faculty with expertise in undergraduate education. Specific to the development of this competency, I engaged in…

1) *Backwards Design*: As a cohort, we read select chapters from Understanding by Design (Wiggins, & McTighe, 2005). This book was critical for my developing Discipline-Related Teaching Strategies as it discussed how to design educational units focused on clear purposes and explicit performance goals, while avoiding *weak educational design* & *excess coverage*.

2) *Led a Cooperative Learning Activity*: I was given the opportunity to teach a 25-minute microlesson to my FAST cohort and the FAST/CIRTL steering committee to incorporate/demonstrate cooperative learning in the lesson. I taught a lesson from a photosynthesis module in Plant Physiology I developed in ISE870.
3) *Designed Discipline-Specific Content*: As a part of my Teaching-as-Research project, I developed three quantitative reasoning exercises aligned with learning modules (plant-water relations, photosynthesis, and metabolism) in an upper-level Plant Physiology course. Each of these exercises incorporated problem-based learning (i.e., case studies).

**Artifact**



Plant Biology Department, CNS

**Plant Physiology: PLB 415**

Spring 2022

**PART I – Course Information**

**Instructor:**
*Professor*: Luke M. Gregory
*Email*: greg0215@msu.edu
*Office*: Room 310, 612 Wilson Rd, East Lansing MI, 48824

**Class Meeting Times:**
*When*: Monday, Wednesday, and Friday from 10:20 - 11:10am
*Where*: Plant Biology Laboratories, room 247

**Course Description:**
This course serves as an introduction to plant physiology for third- and fourth- year undergraduate students in the plant biology department, though it is open to anyone wanting a comprehensive understanding of plant physiology. The curriculum balances molecular and ecological aspects of plant physiology, covering three main themes: *Transport and Translocation of Water and Minerals, Biochemistry and Metabolism*, and *Growth and Development*. Within a "molecules to ecosystems" approach, students will get an in-depth understanding of mineral nutrition, photosynthesis, plant primary metabolism, key plant developmental processes, the action of plant hormones all in the context of both abiotic/biotic factors. In addition to the lectures, a quantitative understanding of plant systems and the physiological processes covered in the course will be emphasized through a series of problem sets and in-class exercises.

Complementary laboratory course (PLB 415-01/02) provide hands-on experiences to these topics.

*Course Objectives*: Given that the topics covered in this course build on each other, students should develop the listed learning outcomes as the course progresses. By successfully completing this course, you will be able to …

- Identify how plants use innovative approaches for acquiring and retaining water.
- Explain (at the cellular- and molecular- level) how different macro- and micro-nutrients effect plant growth and development. Scale the impact of micro-scale nutrient deficiencies to whole-plant physiology.
- Outline how environmental growth conditions (temperature, light, $CO_2$, $O_2$) effect the efficiency of photosynthesis?
- Diagram the journey/metabolism of a molecule of $CO_2$ from the atmosphere to starch/sucrose. Explain using the diagram how photosynthetic leaves spend their carbon income in the day and at night?
- Understand at the molecular level how plant hormones are perceived, transduced, and their effect at the macro-scale (whole-plant).
- Propose plant care practices that tie in one or more physiological mechanism you have learned in this course.

**AND**

- Generate *"defensible explanations"* to describe plant physiological phenomenon by…
  - …conceptualizing and constructing various plant systems (i.e., from whole-plant to organelle-level) and plant physiological processes
  - …developing and revising mathematical models to explain a biological systems and phenomenon
  - …deploying biological models to make predictions about plant processes
  - …determining trends in data and defending them with biological arguments
- … participate effectively in cooperative learning exercises with collaborative teams to solve challenging questions in plant physiology discipline

**Artifact 1**. Plant Physiology Sample Syllabus

**Artifact Rationale**

To create a successful curriculum in the classroom, instructors are trained to design syllabi that provide students with the most transparency regarding course expectations. Syllabi of this design establish classroom procedures and norms early, define attainable learning goals and objectives, specify assessment approaches, and outline what is expected to transpire during the course. This artifact showcases my competency in developing discipline-related teaching strategies, demonstrating my ability to create clear, structured, and goal-oriented syllabi that enhance student understanding and course transparency.

**Interpretation / Reflection**

I developed discipline-related teaching strategies competency by understanding the theories involved in these teaching strategies and demonstrating proficiency in practical experiences with my peers. Much of the knowledge base I developed in ISE870 was based on active learning practices in science education. The teaching strategies covered in the most detail in the course were modeling instruction, problem-based learning, and argument-driven inquiry. Additionally, we learned how to keep students in the zone of proximal development with these strategies and how to modify instruction if students were to fall off. I implemented these practices when designing a syllabus and microteaching lessons I prepared for my peers.

During my fellowship, I applied these teaching strategies in my Teaching-as-Research project when developing discipline-specific content. These teaching strategies and their alignment with learning objectives are critical in postsecondary education.

Through my experiences in ISE870 course and as a FAST fellow, I have found that I like to structure my lesson plans before getting in front of the classroom. Therefore, in my future teaching endeavors, I imagine I will continue to use the Backwards Design when developing learning experiences for students and implement multiple discipline-related teaching strategies to impart instructional material to future students effectively.