Curriculum Development Grant

The Redesign of Human Anatomy and Physiology (Biology 107) from a Traditional Lecture Format to a Flipped-Lecture and Active-Learning Experience

Summary of Previous CD Grants: I have received four curriculum development awards. Per the faculty development guidelines for CD grants, I have listed the last *three* that were awarded. These awards have had a profound and lasting impact on my teaching pedagogy.

1) AY 2017-18: This CD aided in the full course redesign of an existing animal physiology lecture offered in the biology department, the lecture component of **BIOL 307 Animal Physiology**. The CD enabled me to "flip" the lecture and to leverage class time for active learning pedagogy. The award provided a stipend of $2,000. The redesigned lecture was first taught in the Fall of 2018 and has been taught 5 more times since (Fall 2019, 20, 23, 24, 25). The course was not taught in Fall 2021 or 2022 due to my teaching needs changing in 2021 and my sabbatical in 2022.

2) AY 2018-19: This CD aided in the full course redesign of the Biology department's first year **BIOL 101 General Biology** course. The CD enabled me to "flip" the lecture and leverage class time for active learning pedagogy. The award provided a stipend of $2,000. The redesigned lecture was first taught in the Spring of 2019 and has been taught 3 additional times since (Spring 2020-2022). In 2022, I transitioned away from teaching Bio 102 as I began teaching Bio 108.

3) AY 2022-23: This CD aided in the redesign of the Biology department's first year **BIOL 108 Human Anatomy and Physiology** course. The CD enabled me to "flip" the lecture and leverage class time for active learning pedagogy. The award provided a stipend of $2,000. The redesigned lecture was first taught in the Spring of 2023 and has been taught 3 additional times since (Spring 2024, 25, 26).

A. **Narrative:**

Course Description: Human Anatomy and Physiology is a two-semester course with a lecture and laboratory (BIOL 107 – Fall; BIOL 108 – Spring) that is a requirement for Nursing, Neuroscience, Nutrition and Kinesiology majors. The course also enrolls students that have career aspirations involving physical or occupational therapy or chiropractic medicine, given that a semester or year-long sequence in anatomy is often a requirement for entrance into those graduate programs. I have taught the Spring BIOL 108 lecture since 2023 and I will take over the lectureship duties of BIOL 107 beginning in the Fall 2026.

Historically, BIOL 107 has been delivered in a traditional lecture format, with students passively listening as the instructor explains content via powerpoint/whiteboard. This represents the standard method of content delivery for large introductory undergraduate STEM courses based mostly on convenience to the instructor; however, mounting evidence shows that higher learning gains are made when active learning pedagogy, such as flipped classroom and interactive, group-based classroom activities are included in undergraduate science courses[1-4].

Based on this, I am seeking a CD award to conduct a full redesign of BIOL 107 lecture from a traditional format to an active-learning approach.

The redesign will involve flipping the content delivery, a practice that I utilize in all of my other classes. The flipped approach will require students to prepare for each class, often by watching my pre-recorded lectures in addition to short readings. This will enable each class period to be refashioned in a manner that focuses on higher order learning gains by incorporating active-learning strategies, such as problem solving, student-led instruction, collaborative learning, computer simulations, etc.

Course Content: The year long sequence in Human Anatomy and Physiology examines the form and function of key body systems. BIOL 107 provides foundational knowledge to students, including a study of basic cell biology, common metabolic processes that occur in the cell, organization of cells into tissues and in turn how those distinct tissues come together to form the body's organs. In terms of organ systems, students learn about the skin, bones, reproductive, endocrine and muscular systems. The course also covers basic genetics and inheritance, enabling students to understand how their bodily form and traits are derived from their parents.

Bringing active learning into the science classroom deepens the learning gains of students[4]. Herein, active learning is defined as any activity (besides lectures) that engages students through hands-on participation, solving of critical thinking questions and/or verbal communication with peers. To more fully contextualize the learning gains and student development that can be achieved in an active-learning classroom, let us consider the same BIOL 107 lesson involving the form and function of human skin in a traditional lecture vs active-learning classroom.

Traditional lecture: A typical class period covering the skin would utilize microscopic images of the skin overlaid with a seemingly endless barrage of terms. One at a time the instructor would point out each term and define it as students passively take notes. The instructor would then tell the students that they need to memorize the terms and their definitions on their own time. This type of a lesson makes the skin come off as a checklist of terms that need to be learned, rather than an exercise in critical thinking or one focused on student understanding of the functional importance of the skin.

Consider now the same lesson in an *active-learning classroom*. Students will have learned a smaller, targeted list of terms of the skin (only the most important ones) and their functional importance in a pre-class video. They will make notes and drawings at their own pace and bring those to class. In class, students will be seated at tables with five other students and will work in teams on the following two activities.

> Activity 1 - Have a Debate. The outermost of two layers of the skin is known as the epidermis and it has FIVE distinct cellular layers. Students will carry out a debate on which cellular layer is the most functionally important. To do this, five students will each be given a "role" as one of the five epidermis layers. The student role-player must argue

why their layer is the most important. The sixth group member will serve as the judge and will report out their decision to the entire class. This activity will make the function of each epidermis layer more “sticky” to the students while reinforcing critical thinking and building a sense of community in the classroom.

Activity 2 - Solve a Crime. This activity is adapted from a published case study entitled “Worst Thief Ever” which adds a forensic storyline to studying the integumentary system[5]. Students must examine images of skin and use witness statements at a crime scene to determine which of the three suspects could have committed the crime. Each suspect has certain features of their integument, such as differences in skin pigmentation, hair color, presence/absence of a tattoo, that student “detectives” must sift through to solve the crime. When the author of this storyline added it to her undergraduate classroom, 86% of students reported an increase in their interest in studying the skin[5].

In the active learning example, students are participating in diverse ways and the learning is occurring through critical thinking and communication with fellow classmates. It is my contention that the latter, active-learning classroom approach provides a deeper learning experience that students actually prefer! I have evidence to support student satisfaction in this approach. Consider student evaluations from my most recent BIOL 108 course. In 2022, with the support of a CD grant, I re-designed BIOL 108 from a *traditional lecture* to an *active learning format*. In my most recent iteration of BIOL 108 I received 34 student evaluations. When asked about the course design and format, all 34 responded positively. Here are a handful of those responses:

> *Dr. Schwend has designed this course to be very helpful to students*
>
> *I loved the way that Dr. Schwend used the out-of-class videos to do the general learning at home and the application in class*
>
> *Learning was very interactive and engaging*
>
> *I think it's nice that we weren’t expected to know every single detail of every biological process but rather analyze how it is important to us*

The active lecture classroom also breaks down a troubling dichotomy that often exists in introductory science courses that entail a passive lecture supplemented with a more active laboratory. This common form of STEM instruction reinforces the false narrative for students that the lecture is an instructor-centered event with the aim of helping them memorize facts to be regurgitated on homework and exams, while the laboratory is the only student-centered time where active application and synthesis of information occurs[2]. The majority of lecture class time under this format is not concerned with deeper student learning gains and only supports what noted educational psychologist Noel Entwistle refers to as "surface learning" for the students[3]. As a result, traditional physiology education fails to produce students that can clearly apply their knowledge on key standardized exams, such as the NCLEX (required for Nurses) or GRE

(required for PT, OT, CM programs)[3]. With the help of this CD grant, 100% of lecture and lab class time will be student-centered and wholly focused on knowledge application through active learning exercises.

Course Assignments: The overall goal of flipping this course is to increase the opportunity for collaborative learning (student-student and student-instructor interactions) to occur as students work on higher-order assignments focused on application, analysis and synthesis during the class period. These assignments will vary and include case studies, debates and discussions, drawing structures on the whiteboard, think-pair-share and group quizzes. All assignments will be open-note and open-book to reinforce student usage of these resources.

Fortunately, in the field of anatomy/physiology, a wealth of high-quality active learning exercises for all topics covered in BIOL 107 are widely available via two main repositories; (1) Advances in Physiology Education journal and (2) Human Anatomy Physiology Society. I have used these resources in my other flipped courses.

Teaching Approaches: This course redesign adheres to multiple lines of effort at the institutional and departmental level to incorporate active learning, student-driven inquiry and efforts to improve student information literacy and communication, both in oral and written form, while involving more opportunities for higher-order cognitive skill development to occur in the classroom (e.g. apply, analyze, create, evaluate).

This course will directly address a number of desires that have recently been outlined by the university's stakeholders and practiced within our department. First, by incorporating a variety of different learning activities, beyond just high-stakes exams, students will have a more holistic learning experience that causes them to more deeply think, listen, collaborate, teach and communicate. Second, the collaborative nature of the learning environment in the course will enable students to learn to work and solve problems in the company of their peers. This should foster a greater sense of community among diverse student populations here at IWU while also providing students with a transferable skill for their careers.

B. Rationale for Grant Request

Three aspects of course design and preparation will require significant time investments. I am requesting that the CD grant be used as a stipend to acknowledge the time commitment. I am not receiving any additional funds from elsewhere to support this work.

1. While I have much experience teaching in the flipped model, I must admit that the sheer quantity of students in BIOL 107 represents a new challenge for me. For example, in the Fall of 2025 the class launched with 130 students. I have begun working with IWU leadership and faculty colleagues as we transition from one section of 100+ students (how the course has forever been taught) to two sections with a cap of 60 seats (I received Provost approval for this already). Using the active-learning format requires sections to be smaller for three main reasons (1) there is a limited amount of materials (hand-held whiteboards, manipulatives) that need to be

shared among seven or eight tables of students, (2) students are more inclined to ask questions as they are navigating the in-class activities and (3) a smaller student:instructor ratio in the active-learning classroom is important for community and relationship building. For this reason, I will spend the Spring semester working with the Registrar's office and faculty in Nursing, Psychology and Kinesiology to find two additional time slots for two additional sections.

2. Making and editing digital recordings of lecture content for students to view prior to class. In order for the BIOL 107 students to work collaboratively on assignments in class with the course embedded tutors and myself, the lecture content will be digitally (on-line) accessible to students so they may engage with it prior to class. I record my lectures using Screencast-o-Matic and then embed them directly into Canvas. I organize Canvas as a one-stop shop where each lecture day has a "what to read, view and watch" page complete with the day's readings, lecture slides and my videos.

I have ample experience making engaging "digital" lectures and have been invited by CETAL to present on the topic and showcase some of my flipped lectures in the past. This work is quite time consuming, involving prep of the lecture, the writing of a script and filming the lecture. I then edit each lecture to (a) assure accuracy, (b) enhance quality, and to (c) incorporate audio/visual effects to make it more engaging. Finally, I break up the lecture into chunks of 5-10 minutes that represent distinct topics and make viewing them a bit more manageable for students Specifically, students have told me that appreciate being able to view 5 to 7 shorter videos, each having a distinct topic, as opposed to one long lecture without distinct topical breaks. Carrying out all of these steps is time-consuming but they are based on positive feedback from students and so I do not want to cut any corners. This will require time and I need to begin the process this Spring semester to ensure I don't fall behind and am then forced to make lower quality video lectures.

To ensure that students are engaging with the lectures outside of class and are adequately thinking through the content, I begin each class period with a short quiz. These quizzes are open-note, which reinforces good note-taking. Given that the students sit at tables in class, the quizzes are designed to be taken in teams of students. The collaborative nature of the quizzes leads to discussion among peers which emphasizes teamwork and accountability. Thus, a further aspect of this course redesign will entail the creation of the brief quizzes that accompany the lectures. I have a lot of experience in doing this, but again it requires a lot of time.

3. Acquiring, developing and assimilating course assignments that accompany the online lectures and can be worked on in class. In the process of planning each lecture, I will identify 1-2 major concepts for which students would benefit from having in-class time to work on and apply their lecture knowledge on an activity centered around the concept. Typically, the main objectives for each lecture all revolve around one key, central outcome. For example, a key anatomical outcome when we are studying the lung is to describe the anatomical pathway that is laid out from the nose, where air enters the body, to the deepest lung structure, where oxygen moves from breathed air and is pulled into the body's bloodstream. For this class, I would need to identify a way that students could draw out the pathway and answer questions on the

importance of each anatomical landmark. In some cases, a good activity already exists and has been shared at one of the three websites I mentioned above that constitute good resources. Still, it takes time to find these resources. Alternatively, I need to create my own. Either way, finding the activity and preparing it to be carried out in class will require substantial planning and this work must begin in the Spring.

In conclusion, to carry out these necessary aspects of course design and preparation I will require a stipend of $2,000 to buy the necessary time. I do not anticipate any other aspect of the redesign that requires funds. Digital recording and editing software are already available. Literature related to flipping classes is freely accessible through the Ames library resource network. Office supplies or research equipment to be used in class are already purchased and on- site.

This grant will have a lasting impact on my pedagogy in biological education. Undergraduate biology education is changing. Catalyzed by the 2015 Vision and Change document in undergraduate biology education, educators are becoming more aware of the pitfalls of traditional lecture-based pedagogy as well as the learning gains associated with active-learning strategies and laboratory investigations that promote inquiry, information literacy and open-ended lines of investigation. It is clear that biology departments that fail to adapt to lessons learned in Vision and Change are being outcompeted in attracting students by peer institutions and are providing inferior learning experiences to their current students. In line with my own recently revised BIOL 102, BIOL 307 and BIOL 108 lectures, this revised course aims to provide our current biology students with the most cutting edge and effective teaching pedagogy.

C. IACUC Review N/A

References:

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4 Anderson, G.L., Passmore, J.C., Wead, W.B., Falcone, J.C., Stemel, R.W., and Schuschke, D.A. Using "Active Learning" Methods to Teach Physiology. Medical Science Educator 2011; 1:8-20.

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