

Course description and redesign

Current design of the course

This course will be taught for the first time in Summer 2016, while the redesigned version of this course will be taught in Spring 2017.

The course as it will be taught in Summer 2016, already includes elements that are meant to differentiate it from the traditional, lecture-style engineering course. In this regard, elements of business schools' "case study" type of learning are introduced in the course. Thus, the latter will be structured around three different types of classes:

1. Lectures
2. Case studies
3. Case histories

Lectures will only make up less than half of the overall class time. They are meant to provide the students with enough background material to be able to address the issues raised in case histories and case studies. As a test, the material of one of the lectures will be recorded and posted on Canvas. The pedagogical objective here will be to provide students with materials corresponding to a basic level of learning and to encourage them to learn this material on their own, while the in-class activities will allow them to access higher and deeper levels of knowledge.

Inspired from business schools' teaching methods, **case study classes** will encourage the students to think about research questions related to the previous lectures' material. In groups of 3 to 4 people, students will be asked broad and open-ended questions such as: "What is the most interesting research direction to follow?", "How would you implement the idea you came up with?" or "What's the pay-off of this research?"

The **case histories** will consist in the presentation and discussion of papers that could serve as a response to the previous case study. Case histories present what actual research has been done in relation to the preceding lecture material and case study, thus giving a conclusion to the three or four classes spent on a specific subject.

Course redesign

The 3 key elements to the course redesign will consist of: (1) the "flipping" of all the lecture materials, (2) the development of extensively annotated course materials facilitating independent work and their continuous improvement, and (3) the utilization of recorded interviews of subject experts to make the reading material "come alive".

(1) "Flipping" the lectures

Even though the course as it will be taught in summer 2016 introduced elements of active learning with the use of case studies and case histories, nearly half of the overall class time will be allocated to traditional lectures. An essential redesign element of the course will consist in the "flipping" of all the lectures in Spring 2017. Taking advantage of the lessons learnt and the feedback that will be obtained in Summer 2016, all the fundamental material of each lecture will be recorded and divided into several short videos. The students will be asked to watch the videos in preparation for the class, and answer to a few short questions about them online.

During the class, the PI will draw the students' attention on the main "take-home messages" of the lecture, and the students will have the opportunity to ask for clarifications regarding the topic. The class will consist of activities such as in-depth readings on the subject, discussions about the empirical applications of the material, or a Q&A between the PI and the students. All these activities aim to bring the students not only to a higher level of understanding of the topic, but also to teach them to develop,

formulate and justify their ideas on the subject. This will be an opportunity to turn the class into a more interactive and active environment in which the material will be taught in a more personalized way. Thus, this course will serve as an innovative forerunner in both the fields of bionanotechnology and active learning using a flipped classroom method.

(2) Development of extensively annotated course materials

Another addition to the course will be the annotation of the papers and online material that will be presented in the case histories. The objective of this annotation will be to draw the students' attention on the ideas of interest that will be discussed in class. The students will hence have a better idea of what they should look for in each paper. By giving them some perspective as of the point of view they should adopt when reading the material, this measure will also serve the higher objective to turn them into more effective readers when provided with a scientific paper.

Furthermore, the annotation of the course material will open the door to online and out-of-classroom interaction both between the students and their peers and between the students, the PI and the TA: in addition to the annotation made by the PI, the students will be able to comment the paper, discuss it online with each other, ask their questions. The PI and the TA will have access to the commented file and will be able to provide the students with further explanations and guide their deeper understanding of the course material in a more specific and centered manner. An important point to keep in mind is that the additional "online" help provided by the PI and the TA will be "constant" and not limited to class hours or office hours. Consequently, this measure will both facilitate the students' independent work and continuously encourage them to actively learn more on the subject.

(3) Interviews of subject experts

A key, novel feature that will be added to the course thanks to the RFP grant is the interviews of current researchers in the field of bionanotechnology. The interviewees will consist of colleagues and past students of the PI who now work in companies and universities across the world.

Providing an access to different researchers' perspective and insights, the interviews will give the students an idea of all the different ramifications of the field of bionanotechnology. The interviews will be incorporated in the course material and a part of the lectures will be dedicated to discussing them. Thus, even within a lecture, the rhythm will change and the students will be more engaged. These discussions would serve the above-mentioned purpose of making the course more interactive, encouraging the students to be learning the material in a more active way.

These interviews will also show how the course's material is currently used and looked upon by researchers who have dedicated their professional lives to bionanotechnology. Consequently, the material will gain a more applied sense in the students' eyes.