My Goals as a Teacher

Even at a young age, my favorite question was one simple word…”Why?” So many of our scientific discoveries begin with simple questions of “why” and “how” and life-long curiosity is rooted in asking these simple questions. The process of learning does not stop at just asking the question, but with following through with answers or solutions. My natural curiosity was fostered by my father, who nurtured my interest in science with chemistry kitchen experiments and shark dissections, and through teachers, who recognized my inquisitive nature and strove to develop my process of inquiry. It is these people that I see as role models in my teaching career and who I strive to be. It also highlights my ultimate goal as a science educator: I want to make science real for students—I want my students to practice and experience science the way a mechanic or musician practices their trade. A violinist may learn scales and arpeggios, but their application is not apparent until having to play an orchestral piece…yet that is exactly when it is truly the most exciting to be playing the violin.

I see my role as a coach to guide students through the learning process. I believe my students should leave my classroom and laboratories with a solid foundation in basic scientific concepts, critical thinking skills and practical application skills to solve real-world problems. I will provide them the learning environment to face these challenges, to observe, correct, and explore applicable real-world problems, where the practice, improvement, and mastery is the responsibility of the student. Through practice and critical application of scientific concepts and knowledge, I find students more easily draw connections between the knowledge gained in class and how it will apply to their lives and future careers.

How do I make science real?

My enthusiasm and energy are readily apparent in my teaching style. The teachers I connected with the most were those who had a true passion for their subject and transferred that energy to engage and motivate students. To engage students in practicing science, I use a backwards-design course model using elements of inquiry-based and student-centered learning. I start by asking myself “What will my students be able to do when they complete my course?” I use this guiding question to direct my choice of content, lectures, laboratories and assignments, and to design clear, measurable objectives that range in Bloom’s taxonomy levels. I frame the topics in the form questions to be answered to reflect the process of scientific discovery and to spark natural curiosity, which often begins with an observation and a question. For example, when covering the differences between prokaryotes and eukaryotes at the beginning of my cell biology class, I framed the topic around the question "How are prokaryotic and eukaryotic cells identified?"

In order to get students excited and practicing science, they must be actively engaged in the learning process and take ownership of their acquired knowledge. To engage my students, I employ a diverse range of active-learning methods and student-centered activities to reach the different learning styles and pace of each of my students. The activities are designed to relate directly to the lesson objectives of the topic. At the beginning of class, I immediately prime my students for the day’s topic with an individual or pair activity. For instance, when I taught Cell Biology in the Spring and Fall of 2012, I introduced the topic of the plasma membrane by giving my students 5 seconds to draw a cell and then I asked the students to tell me what they drew. Because most students were only able to draw the plasma membrane and nucleus, this activity quickly and actively engaged students and facilitating an immediate connection to its importance. After lecturing for a portion of the class, I break
periodically to perform individual, pair, or group activities. Activities range from individual assignments, think-pair-share, or polling by a rising of hands. I frequently ask students to write their answers on the chalkboard and importantly, explain their answers to the class, requiring students to be an active participant in the classroom. Though most classes I have taught have been relatively small, these activities could easily translate to larger classes, where I would use clickers or cell phone polling, such as Poll Everywhere. Working in groups, students could explain their reasoning each other and summarize a group statement.

Science is real when it connects to our lives

Nowhere is science more apparent than in our everyday lives. To bring this reality to students, I employ case studies and real-world problems in the classroom and directed group assignments to connect the lessons of the day with events outside the classroom. I frequently used peer-reviewed case studies from the National Center for Case-Study Teaching in Science to connect topics in the classroom to real-world problems. In addition, case studies are a great tool for students to practice higher-order cognitive and critical thinking skills. Because many students in my Cell Biology classes indicated interests in forensic and medical careers, I used the “Mystery of the Seven Deaths” case study to relate the topics of the electron transport chain and oxidative phosphorylation from the perspective of the city medical examiner investigating the poisoning deaths of the 1982 Chicago Tylenol murders. To set the scenario in perspective, I inform my students we are solving a real-life crime and that they will need the knowledge they learn in class to solve it. The students actively participated in solving the case and applying the knowledge in class to why cyanide is poisonous to our bodies. They were surprised to find that this case is the reason for the current safety packaging guidelines of food and drugs. This is just one example of the inquiry-based case studies that I employ in my teaching.

I frequently use directed out-of-class assignments to tie topics to current research and real-world problems. Based on primary journal articles or peer-reviewed case studies, students in groups to complete the assignments to facilitate discussion. For instance, to highlight and analyze the problem of determining the structure of a protein, I developed a directed assignment where students investigated whether Foldit, a protein structure-prediction computer game developed for the lay public, was a better tool for solving protein structures, than the current Rosetta methodology. The students not only related their knowledge of protein structure and function to current research in predicting the structure of proteins, but also practiced data analysis and interpretation and comprehension of scientific texts. Based on evaluations from my Spring and Fall 2012 Cell Biology classes, 85% and 87% of students thought the “course challenged [them] to think critically and in new ways about the subject matter,” with about half of the students in the class strongly agreeing with this statement.

Practicing science in the laboratory

I believe that the laboratory should be used to execute basic knowledge and lessons from class into investigative practice. The scientific method of investigation is itself an exercise in critical thinking and should be treated as such. When I taught Cell Biology in the Spring and Fall of 2012, I designed the laboratory component of the class from the bottom-up using an inquiry-based approach, where students pose and test scientific hypotheses, while developing and applying practical laboratory skills. Though I try use labs that relate to the current topic, this is not always practical using an inquiry-based approach, where many labs span at least 2 lab sessions. I use laboratory not as a means to get the right answers, but as
a tool for students to practice the scientific method of investigation. During their time in lab, students are required to keep a detailed lab notebook as a record of their activities and data and to communicate their results in the form of detailed laboratory reports that mimic mini-scientific articles. In addition, I expect students who complete my laboratory to have the basic skills to navigate any biology laboratory, such as calculating and preparing molar solutions, counting cells on a hemocytometer, and making a graph using Microsoft Excel. I developed a laboratory practical to assess whether my student’s have mastered these basic laboratory skills. I received many positive reviews about the labs from my students, where students said they enjoyed having to do the labs themselves.

Assessing student performance
I am continually assessing my student’s performance using formative and summative assessments. On the first day of class, I use a pre-test to assess retention of concepts from previous courses and to gauge their level of knowledge. Using the pre-test, I determine which topics need to be reviewed. I constantly pose direct-response questions during class, such as polling by rising hands or quick one-word response questions, to both individuals and the entire classroom to keep students engaged and to determine whether they are grasping the key concepts. I include questions that relate to previous topics or to other classes, in order to gauge whether they have retained material and made the appropriate connections to other topics. I frequently ask open-ended questions; especially “what-if” scenarios that push students to use higher order thinking. I find that asking students “Why did you choose that answer” quickly assesses whether they truly comprehend the material. I give short daily quizzes to ensure students have reviewed the previous lecture material and assign weekly pre-class assignments for each topic to prepare students for the day’s activities. I give multiple exams throughout the semester, where a portion (15%) of each exam is cumulative. This ensures that students are continually examining the concepts learned in class and prepares them for comprehensive final exams at the end of the year. For exams and assignments, I use a range of Bloom’s levels, focusing on high-order criteria such as application, analysis, synthesis and critical thinking, which require comprehension of lower knowledge levels. By tying each exam question directly to a lesson objective, I am able to assess of which objectives proved difficult for students and amend my teaching accordingly.

As scientists, we have an obligation to the public and scientific community to communicate our results and I rigorously evaluate this communication in my classroom. For writing assignments, I use defined grading rubrics with explicit criteria. The rubrics are freely available to the students and are reviewed before the given assignment. I require laboratory reports that model scientific journal articles, providing opportunities to practice concise scientific writing, data presentation and analysis. I provide written feedback for each lab report indicating where my criteria were met and where they were not. I find this a valuable exercise for students in revision, where students become better writers in successive lab reports. I also expect my students to write investigate research papers about a particular disease or topic that relates to the class. For instance, my Spring and Fall 2012 Cell Biology classes were required to write a term paper that investigated a particular cell type.

How can I become a better teacher?
After each class, I spend time reflecting and making notes in my lectures to indicate activities that were effective and those that were not. This allows me to make immediate changes to my teaching style and plan my lessons for the future. It also allows me time to think about
whether students are meeting my goals and what else I can do to get them there. I cultivate a climate where students can come to me and express their concerns during the course. I will periodically reserve class time for informal sessions where I ask students how they are feeling about the class so far and if there is anything that I can do to improve. The students I taught at Johnson C. Smith were very open and offered constructive and valuable criticism that I was able to respond to accordingly. I wanted to show students that I want to be the best teacher for them and that constructive criticism is a tool for improvement. I will also amend my current pre-test to incorporate questions from AAAS Project 2061 and give as a post-test to measure learning gains. In addition to student evaluations, I use peer-evaluations to help me improve my teaching and to offer objective insight. While at teaching at Johnson C. Smith, I had a total of three peer evaluations from two separate colleagues, including my teaching mentor at Johnson C. Smith, Dr. Tim Champion. I will continue to use peer evaluations and seek out teaching mentors in willing colleagues. I investigate new teaching methods by attending teaching workshops given by the UNC Center for Teaching Excellence and educational conferences, such as the Association for Biology Laboratory Educators (ABLE). Ideas and discussion at such workshops and conferences helped foster the active-learning techniques I use in class today. My attendance at the ABLE conference prompted my re-design of the laboratory exercises I used in the Spring of 2012 to the inquiry-based exercises I used in the Fall of 2012. I will continue to use the invaluable resources at university teaching centers and science education conferences. I also read scholarly education journals, such as the The Journal of College Science Teaching, and would like to pursue science education research to investigate innovative pedagogical methods.

Educating our communities about science.
I believe it is important for the public and younger generations to see science in practice, so they can understand how science is related to their lives and shed light on our careers as scientists. I have frequently participated in the UNC DNA Day, which sends graduate and post-doctoral students to teach middle and high school students about how the human genome is related to medicine, forensics, and agriculture. I frequently facilitate a module on pharmacogenomics that was designed by graduate students at UNC. Many students enjoy the activities and are surprised to see that scientists look just like them. I plan to continue this practice in my career and a goal for myself as a teacher would be to include service-based learning in my classroom. I would like to develop projects where students could develop modules for elementary school students to conduct and prepare those materials for online distribution for other teachers to use. Young students need exposure to science, to light that spark of interest. It worked for me so I know I can ignite it for others. I hope to inspire students to pursue science careers, but more importantly, to be aware that science is all around them and practiced everywhere, just as I hope my own students do.

Conclusion
I strive to show my students that science is more than knowledge from a book—that the exciting part is not only how we arrived at that knowledge, but also what we can do with it. I try to ensure that each of my students becomes scientifically literate and use the skills learned in my classroom to make informed decisions in their lives. I hope to inspire my students to have successful careers in science, technology, engineering, and medicine. Some my even become teachers themselves. I hope that becoming active participants in scientific exploration will ignite that natural curiosity in all of us that drive us to ask and answer those simple questions of “Why?” and “How?”