Science remains an occupation where knowledge and mastery are passed on by experiential and active learning, and I am excited for every day I get to mentor students and young scientists on their roads to discovery. I am fortunate to get about two invitations a year to guest lecture and I take these opportunities because I value the experience. I am also an active educator through experiential learning for undergraduate interns on my research projects, and advising graduate students, postdocs, and visiting scientists hired on grant funded research. Every day that we do research together, I have opportunities to teach and further their knowledge.

Mentoring

My undergraduate internship program started small, but has improved in educational value to the student over the years. Since 2008, 26 students have participated in internships, with most continuing to careers in agriculture, biology, engineering, and medicine. Since the beginning, I have focused on making the internship a learning experience for the students, as opposed to simply using students as a source of menial labor. The primary desired outcome is that they learn about the scientific improvement of plants for the benefit of humanity. Recently, we took this program a step further by including an independent project component, which is a challenge because the students often are only available for a summer. It started when Marc Pritchard, a returning student, was interested in doing an undergraduate thesis project. Marc undertook a mating experiment to determine the inheritance of reduced saturated fatty acid composition in sunflower. Since that time, all of the students have a project, and with recent students majoring in agricultural business, agronomy, entomology, and engineering, the projects were very diverse and interdisciplinary. I spent a great deal of time with the interns, either planned or not, going over genetics concepts with whiteboard sessions, facilitating group discussions on ethical issues in genetics or related fields, and helping them make contacts with colleagues to discuss interdisciplinary topics. My postdocs, graduate students, and technicians were key to the success of this program, because I promote a collaborative lab culture and they volunteered to help mentor, as well.

I have had the pleasure of advising four wonderful graduate students over the years, two from North Dakota State University, one from the University of Colorado, and one from the University of Minnesota. All of my graduate students were from non-agricultural backgrounds, and were either completely new to agriculture or had only recently begun to study and work in agriculture. To work with them on agricultural-focused thesis topics meant that teaching involved much more than the genetics, bioinformatics, or breeding details of the project. It also required a holistic approach to conveying the importance of the work from practical, socio-political, and economic viewpoints. My NDSU students were particularly unique within their academic department because they were not “farmer’s kids”, but they excelled because of their mostly unbiased viewpoint on science and technology in agriculture. It is clear that the future of food sciences and applied biological sciences will be filled with people with no prior experience with producing food. My newest student is also advised by Nolan Kane at University of Colorado. Developing partnerships like this one with an evolutionary biologist has allowed me to teach applied science to students with a strong basic science background.

I have also had one foreign visiting scientist and four postdocs since 2009. Mentoring scientists at this stage requires work-life balance coaching, refining of their writing and speaking abilities, and guiding them to make convincing arguments. I find the last one to be the most difficult, as postdocs tend to grow accustomed to receiving direction, and find it difficult to develop their own voice in some cases.

Teaching Philosophy and Interests

When I was a doctoral student, I received academic training in active learning strategies at the University of Minnesota with their Preparing Future Faculty program. There, I learned I can apply ideas from research-based mentoring to a classroom setting, and vice-versa. For example, in my lab, we have meetings to discuss ethical or scientific questions occasionally as a way to foster development of critical thinking. Everyone participates in these discussions, including technicians and undergraduate students. Devoting time to discussion of a new research paper or to a scientific ethics question and following up with a structured debate for hot topics would be logical means of developing and fostering critical thinking skills in a classroom setting.

For teaching responsibilities with smaller class sizes, strategies including whiteboard group discussions, peer learning and teaching, and debate, can address questions or to stimulate conversation with students. I would use challenge or CURE projects to supplement traditional lecture, in order to solidify concepts. Nolan Kane has been using CURE projects to achieve this with much success. Each student in his senior-level Genomics course has the responsibility by the end of the semester to assemble a small genome from raw reads and submit it to Genbank. One of my current graduate students was in this class, had no bioinformatics experience prior to the class, and by the end of the semester, submitted the chloroplast genome of *Physalis peruviana* to Genbank. He has since used this knowledge to diversify his bioinformatics experience into relational databases and is now double majoring in Plant Science and Computer Science for his M.Sc.. From the professor's perspective, Nolan has had very hectic final weeks of the semester, mostly helping students with troubleshooting, but has found that the students do very clean and publishable work, while synthesizing and retaining more knowledge and providing favorable feedback. Applying a similar CURE methodology with a breeding program is possible, because our efforts require a lot of specialized phenotyping, genotyping, and statistical modeling that can be made into workable projects for students. Another possible scenario is planning and executing a collection trip for Lewis flax in the mountains, followed by developing a curation and use plan for the resource.

From what I have been told, the SOCR 330 course "Principles of Genetics" will be the responsibility of whomever you hire, and is a large course with around 150 students per semester. Large lecture courses without labs, like these, provide challenges to active learning strategies. I have experienced many of these as a student, and found that large lecture courses tend to be less stimulating. I often felt that I learned less in these settings. So how have my experiences shaped my philosophy? First by recognizing that technology can be a crutch for poor teaching, but does not have to be the enemy of learning. The use of slides shared digitally can be useful for defining terms, graphically showing concepts, and setting up impromptu evaluation and feedback with the help of clickers and other student-held technology. The clickers can help the students to participate by reflecting back to me what they have learned through close-ended questions interspersed through lecture. Alternatively, asking one open-ended question per lecture in a "think-pair-share" format will help students more comfortably fit concepts into an intellectual framework. The second thing I realized was that the "month of lecture followed by exam" method results in last minute cramming and little long-term comprehension of content. This is made worse if there is no lab as a part of the class. So the alternative is to add experiential learning as part of the lecture. One idea is to "take back" the student study time that would normally be set aside for cramming and use it for out-of-class group or individual projects, guided by prompts and help from me. In a Junior-level course, examples include group development of a Frontiers for Young Minds manuscript (https://kids.frontiersin.org/) on the subject of their choice that is revised by students in other groups. An individual project idea is for the student to post a primary research article on Reddit /r/science, followed by guiding and responding to comments by other redditors. The student can follow up with a report on what they learned from the experience. The idea is that the experience will help them comprehend some core concept in their particular area of interest, and provide an opportunity to educate others (inside or outside class) while they learn. Of course, it also provides an opportunity for them to improve written and oral communication ("Find a subject you care about. Do not ramble, though. Keep it simple. Have the guts to cut. [...]" -- Kurt Vonnegut). Exams, likewise, can focus less on memorization and more on integration. By having subject mastery questions and activities throughout the semester, students should require much less exam preparation.