Large classes make it difficult to engage students in a personal way and create environments in which they receive interaction and feedback. Technology may help bridge this gap, but for the most part we haven’t developed really good tools to supplement and augment (not replace) the undergraduate science class. Involving students in real research early on can be very successful, but in large classes it’s challenging to find projects that can be massively parallel but still unique to the student.

The varied backgrounds of students also present a challenge. Some (maybe even many) students coming to a university lack the quantitative reasoning skills needed for discovery-based learning. Without such basic abilities, even the best designed hands-on experience can be lost on a student.

Hands-on projects can transform education by fostering critical thinking and allowing students to apply what they’ve learned. But implementing these projects can be difficult. Here, four HHMI professors share some of the challenges.

**Q&A**

**What challenges do educators face when trying to implement hands-on undergraduate science classes at universities?**

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**Brian R. Crane**

**HHMI Professor, 2014-present**

**Cornell University**

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**Susan S. Golden**

**HHMI Professor, 2014-present**

**University of California, San Diego**

The biggest challenge is inertia. Academic scientists are trying to juggle many different jobs, all of which are important, and only one of which is teaching science to undergraduate students. Once we establish a rhythm that keeps all of the balls in the air, it’s hard to commit the energy required to change the direction or speed of one of those balls. A major change in teaching methodology will affect the other balls, too. The beauty of the HHMI Professors grant is that it facilitates that change, by providing resources for teaching activities that are creative and fun—and thus worth the disruption—and by integrating some of those other activities with the teaching component.

**Darcy B. Kelley**

**HHMI Professor, 2002-2010**

**Columbia University**

The major challenge in creating a more active learning environment at a private research university is stimulating faculty interest. Senior faculty members who came into science through traditional lectures may not see any need for change. Letting junior faculty members create courses from scratch will motivate them to use or create other approaches.

University culture also plays an important role. If laboratory research programs are the chief criteria for funding and advancement [decisions], pedagogical research will be a lower priority for faculty. The HHMI Professors program has raised the profile of the creative educational approaches of top researchers. The challenge now is to bring these approaches to the science faculties.

**Richard M. Amasino**

**HHMI Professor, 2006-2010**

**University of Wisconsin-Madison**

It’s possible to have hands-on undergraduate science classes that don’t manage to “turn brains on,” and it’s possible to have brains-on undergraduate science classes that are not hands on, as long as active learning is involved. But ideally, most hands-on undergraduate science classes should be brains on as well.

I define active learning as using one’s brain in an active way. Listening to a lecture is passive. Students solving problems posed to a class is active, as is defending one’s answer to a problem. Hands-on learning can be passive, however, if it is an exercise during which students’ brains can “zone out” while they are doing it. Active learning is important because students must work, and even struggle a bit, with the subject material to learn it in a meaningful way.