



WHAT WORKS - NSF DTS COMMENTS

IMPRESSIONS OF STUDENT LEARNING II

Project Kaleidoscope: *If a visitor were to come into your classroom/lab, what impression would they leave with about the learning experiences they see the students having?*

Evelyn Hu— University of California, Santa Barbara **2005 NSF DTS Award**

- ◆ For the classroom: an environment that encourages questions, that solicits opinions from students, that tries to bring in real-world applications and ideas.
- ◆ For the lab: a broad variety of different projects, an easy interaction with students, a collaborative environment that encourages discussion, initiative and exploration.

Ken Ono— University of Wisconsin-Madison **2005 NSF DTS Award**

- ◆ The visitor would note the active involvement of all members of the research team. The students are not afraid of asking “dumb questions” and they work late. Basically, I hope that the visitor would be impressed by level of energy in the research team.

William McCallum— University of Arizona **2005 NSF DTS Award**

- ◆ I had an opportunity to observe myself teaching recently, through a videotape of a class I taught to University of Utah math majors planning to become high school teachers. The thing that interested me as I looked at these tapes was how much care it takes to get students to pay serious attention to the ideas of mathematics, particularly in algebra.

Students are accustomed to thinking of algebra as following correct procedures, not reasoning about numbers. When you do manage to open their eyes to the revelation that the symbolic language of mathematics is actually about something, they can be quite delighted.

Chris Rogers— Tufts University **2003 NSF DTS Award**

- ◆ I would hope that the visitor would leave with a better understanding of fluid mechanics or robotics. I would also hope that the visitor leaves curious and interested in learning more. As to the impression of the class itself— I am not sure— probably that the students are enthusiastic and the class is slightly chaotic.

Comments from NSF Distinguished Teaching Scholars (DTS)

ATTRIBUTES OF UNDERGRADUATE STEM FACILITIES: THEN & NOW

THEN

Uni-disciplinary
Fixed labs
Teaching focused
Hands-off
Interaction tolerated
Independent projects
Limited computing
Larger class sizes
Few instruments

NOW

Multi-disciplinary
Flexible labs
Learning focused
Hands-on
Interaction encouraged
Group projects
Ubiquitous computing
Smaller class sizes
Proliferation of instruments



IMPRESSIONS OF STUDENT LEARNING II

**Paul Bierman—
University of Vermont
2005 NSF DTS Award**

- ♦ Energy, fun and hard work! It is my love of science and fascination with the Earth that drives me to do what I do every day and that's what I try to convey to my students at all sort of levels. Sure science and learning are hard work but isn't everything that's worthwhile?
- ♦ In my classroom, there's lots of talking and moving around, even when I am teaching 230 students in an introduction to Earth Hazards class. The TAs and I walk the aisles. We ask for students to shout questions out to the group. We try our hardest to get people to think, to speak to each other, to question what they think they know.
- ♦ We get people down front doing silly things like using giant slingshots to impale birthday cakes with apples— the best we can do to simulate asteroids striking Earth. The analogy's not perfect but I can tell you they never forget the demonstration and they walk away laughing, knowing that things fall from the sky, and realizing that their professor is a person who likes to have fun too. My former chair used to remark that I taught 200 students like I was teaching 20. He was right on target.

**Thomas Banchoff —
Brown University
2004 NSF DTS Award**

- ♦ Student responses seem to drive the entire enterprise, either comments made in class to my semi-rhetorical questions, or suggestions that come from their submissions to homework and reading assignments. Often those responses appear on the computer screen attached to my laptop, along with interactive demonstrations prepared by students working with me over the summer, often modified by students working individually or together on projects arising from conjectures in class or online.

The new conjectures that we will examine before the next class meeting arise from the class interaction and show up within one day as formal assignments or discussion questions, both of which receive online responses. The visitor receives the impression that she or he has seen a process, possibly that she or he has been part of it.

**Dean A. Zollman—
Kansas State University
2004 NSF DTS Award**

- ♦ His/her impression would depend on the topic, the type of students and even where we are in the learning process about a particular topic. I tend to vary the learning experience considerably to meet the needs and objectives at the moment. In most cases I would hope that the visitor would come away with the impression that the students are learning rather than I am teaching.

That is, the students are actively engaged in a process that leads to better understanding of the principles of physics rather than me telling the students what they need to know. However, occasionally, the learning process is best dealt with by providing information for the students.

So, a visitor who came to the class several times would see several different methods of learning and teaching. I would hope that the overall impression is that I modify the learning process to work best with the situation at hand and that the style of teaching and learning changes frequently.



IMPRESSIONS OF STUDENT LEARNING II

**Lee Spector—
Hampshire College
2003 NSF DTS Award**

- ◆ On a good day students would all be “doing their own thing” to a large extent, consulting with me and with each other from time to time. My primary pedagogical strategy is to encourage individual engagement with open questions that students find personally captivating.

I prefer to attend to elements of the standard curriculum later, as needed to support project work, after students are actively engaged in projects of their own devising. This can be difficult to arrange in a classroom setting, and sometimes my classes are more conventional and oriented toward large groups than I would prefer— but immersion in projects driven by individual student interests is usually my goal.

**Kenneth G. Tobin—
City University of New York
(CUNY)**

2004 NSF DTS Award

- ◆ We use a variety of data resources to learn from this collaborative research: video and audio recorders to obtain digitized records of interactions that occur during learning; and collecting and studying artifacts from classrooms in which we undertake our research.

Beyond class time, we discuss what happened with teachers and students; then, the visitor would see that in our research lab, we do intensive analyses of data resources, using digital media and software tools that allow us to study discourse and video images intensively. Thus, just as the teaching is collaborative, so too is the analysis and interpretation. Our collective goal is to obtain insights into how the quality of science education can be improved in public schools in urban areas.

**Julio J. Ramirez—
Davidson College
2004 NSF DTS Award**

- ◆ “Wow, that was a high-energy lab!” Our laboratory environment reflects our eclectic approach to neuroscience, which is a mixture of neuroanatomy, neurophysiology and behavior. The laboratory walls are adorned with a collection of prints ranging from Georgia O’Keefe to “Techno-Brain” and the rooms are filled with music ranging from Amadeus Mozart to Brandy to Paquito D’Rivera.

In one corner of the lab, a senior majoring in neuroscience will have been teaching a sophomore psychology major how to properly place a coverslip on a section of brain tissue attached to a glass slide. Across from them, the lab tech will have just finished running a histochemical reaction on brain material from one of our experiments.

In the adjacent room, which houses our microscopy laboratory, a pair of junior biology majors will have been analyzing brain sections on our image analysis system and a senior psychology major with a neuroscience concentration will have just completed reading a paper relevant to our research effort. The lab throbs with the energy of youth, discovery, art and science.



IMPRESSIONS OF STUDENT LEARNING II

**Harry L. Shipman—
University of Delaware
2003 NSF DTS Award**

- ◆ Visitors are often surprised that they are asked to work not just visit in the back row. A few years ago, Steve Sobek, a local newspaper reporter, sought to do a profile on me and asked to visit my “Science and Religion” class. I asked him to sit with a group, and hopefully, to contribute to the group discussion.

Each of my classes is a combination of some teacher-talk and some group discussion. Visitors usually leave with the impression that students’ minds have been engaged in whatever issue, problem, question, or task that their group has been assigned. They realize that a noisy classroom— students talking to each other— is often a sign of successful teaching (as long as the students are on-task).

- ◆ I haven’t stopped lecturing. There are uses for lecturing, but simple delivery of information that is otherwise available in a book or on the world wide web is not one of them. Most of the time, I do lecturettes (15 minutes or less) instead of lectures. My educational research— and that of others— shows that for a wide variety of audiences, attention fades after about 15 minutes.

**Mary Lee Ledbetter—
College of the Holy Cross
2003 NSF DTS Award**

- ◆ Different impressions would be gained from classes with different groups of students. If they were interdisciplinary College Honors students in our team-taught Human Nature course, they would see a lively discussion among opinionated, thoughtful students of various majors on a topic drawn from the week’s reading, which might be Shakespeare’s *The Tempest*, Karp’s *Speaking of Sadness*, or Darwin’s *Origin of Species*.

If they were students of Cell Biology in lecture, they would be closely attending to my presentation on the topic of the day, illustrated with microscopic images, video clips, and data of other sorts, linked closely to the exercises they themselves would carry out in laboratory.

From time to time they would raise questions of clarification or of curiosity, linking the ideas to other areas of their learning. Cell Biology lab itself is much less formal, with students working in groups at their own pace, visiting, joking, and engaging me in conversation.

In the research lab a visitor would likely be impressed by the seriousness and enthusiasm of the students as they learn to discover new knowledge for themselves. If the day were one where the experiments were not behaving, they would sense frustration and dogged determination; if it were a day of success, the excitement would be palpable.

**Richard A. McCray—
University of Colorado- Boulder
2002 NSF DTS Award**

- ◆ S/he would notice that, the students are much more visible than in a traditional class. I don’t lecture much. I spend most of my time probing what students have learned and working through their misconceptions.

Students are expected to come to class with prepared answers to questions that have been posted on the class web site. Often, students will disagree. On the best days they engage in heated debate. We don’t try to cover as much material as in a traditional lecture session. I try to run a student-centered classroom. So they do most of the work.



IMPRESSIONS OF STUDENT LEARNING II

**Joseph O'Rourke—
Smith College
2001 NSF DTS Award**

- ♦ A good portion of the work I do with students is indistinguishable from play: We tape bent straws to the table, cut out shapes with scissors, build polyhedra out of playing cards, and puzzle over images rotating on a workstation screen. Most of the work is fun, and when we feel close to a discovery, exciting. I should add, however, that the norm is a state of mild befuddlement, a state one grows used to in research.

**Daniel J. Klionsky—
University of Michigan-
Ann Arbor
2003 NSF DTS Award**

- ♦ When I have had faculty colleagues visit my class, they usually express surprise at how the students are prepared to discuss the day's topic. They realize that this is one of the goals of my approach, but it is something else to see this in reality. For example, part of the course deals with the regulation of metabolism as exemplified by the lac operon. At the start of the corresponding class session I draw a line on the board representing the operon and ask the class to name the different segments.

- ♦ I then ask them to tell me the rules for which regulatory components bind and under what conditions. Students taking a lecture course typically are not able to do this when they arrive for class because they have not done the reading or have not paid careful attention to the material; however, learning the parts of the operon and the rules for binding are a matter of memorization.

There is no real need for me to read/relate that information to the students in the form of a lecture, and that is borne out by the fact that the students in my class are able to answer these straightforward questions about the lac operon when they walk in the door.

The real point is to see if they can now work with that information to determine whether transcription occurs under different nutritional circumstances. That is, do they understand the concept of regulation? Memorizing the components and binding sites is not important per se, it simply serves to give us a common language and starting point.

From there, the students can attempt to manipulate the information to answer practical questions. Because the students try to do this during class time, they can ask their classmates or me for assistance, something they cannot do as easily once they have left the classroom. I can also gauge the students' comprehension during the problem solving and decide if they need additional problems on a particular topic or whether they are ready to move on.

So to get back to the question, visitors are surprised to see that students in introductory biology can come to class prepared and that they are then able to answer questions or work through problems that are fairly advanced.

**Arthur B. Ellis—
University of Wisconsin-
Madison
2001 NSF DTS Award**

- ♦ Probably that we have a lot of fun and that we find a great deal of synergy in our research and educational activities. We keep many hands-on demonstrations in my office for visitors to play with, and use these to talk about the frontiers of research and technology. Our labs are a mix of research instrumentation and instructional products in various stages of development.



IMPRESSIONS OF STUDENT LEARNING II

**Nicholas J. Turro—
Columbia University
2002 NSF DTS Award**

- ◆ A visitor would find a group of students who are in a learning process in which one of the most engaged students is the instructor. I've always felt that to be an effective teacher you've got to get into the head of the student and try to understand the arduous process of learning a subject.

I'm a fan of the notion that we create our own knowledge best by a combination of distributed learning in groups as well as the hard work of scholarship, reading extensively and practicing with relevant problems.

- ◆ To me, the learning experience involves a process that is independent of content. Good teaching and learning integrate content with context and cognition components. An effective teacher employs the integration explicitly or implicitly.

The context is connecting the content to issues that are important to the student and provide a motivation for the student to learn. The cognition component provides a set of intellectual techniques that are powerful for learning in general, like peer interactions in learning, active learning, and student responsibility for learning.

**Tanya Atwater—
University of California,
Santa Barbara
2002 NSF DTS Award**

- ◆ In lower division lectures I present and explore the most beautiful examples I can find for each phenomenon— giant crystals, beautiful slide images, the most pleasing map presentations, the most vivid visualizations I can muster.

Of course, I also insist that they read and learn the basic material and I keep a running feedback going to reinforce this: "question of the day" each lecture, term papers, lab reports, tests. I also believe in the crucial importance of personal, "hands on" experience and have revamped the labs to be more fun and to include more field experience.

- ◆ In upper division and graduate classes, I am primarily trying to help the students prepare for their professional lives. I still include my passion (can't help it) but it is only a reinforcement of a passion most of them have already.

My specialty, plate tectonics, is an excellent vehicle for bringing together disparate information from their other geo-classes and for constructing a broader mental order— a world image. I also include many activities in these classes that develop important skills: map interpretation, literature searching, paper writing and critiquing, cooperative learning, oral presentation.

**Chris Impey—
University of Arizona
2002 NSF DTS Award**

- ◆ The most important impression would be that learning is a dynamic process, that teacher and learner must both be engaged, that all knowledge must be challenged before it becomes part of our world view.
- ◆ There is a concept that has emerged from the study of artificial life-computational processes that mimic biological processes—that says that complexity and life evolve at the boundary between order and disorder. A classroom is full of complex interactions. If the pattern and order is too rigid, then students follow a preset framework and are not induced to think and question what they know.

This is like passively reading a textbook or content on the web. On the other hand, if there are too many tangents or too many interruptions to the flow, the result is chaos. The best classrooms combine a real sense of direction with a liberating freedom in the expression of ideas.

- ◆ At most universities, the large lecture class will be with us for the foreseeable future. Luckily, there is a wide range of active learning techniques that can engage students in their own learning. I try to use as many as possible of these in my classroom—small groups, pair-share, preceptors, polls, debates— these techniques work in almost any discipline. 

IMPRESSIONS OF STUDENT LEARNING II

**Robert L. Devaney—
Boston University
2002 NSF DTS Award**

- ◆ A visitor to the mathematics courses I now teach would probably marvel at how different these courses are from the way they were in ancient times (pre-1985). Now, with the computer at my side, I can have my sophomore level students tackle the kind of real-world differential equations that were impossible to solve in the old way—when all we had were very specialized analytic tricks and the only differential equations of interest were usually linear.

Now I can give my students a glimpse of what is new and exciting in mathematics, instead of confining my attention to seventeenth century ideas from calculus. Finally I can introduce very simple-sounding questions that relate directly to the course content and then challenge them to get involved in contemporary mathematics.

**Gretchen Kalonji—
University of Washington
2001 NSF DTS Award**

- ◆ I would hope that the visitor would hone in on the atmosphere of mutual respect and genuine affection that characterize most of my interactions with students, and that also characterize the interactions between students themselves.

Basically, I love being with them, and our goals are quite similar, so the atmosphere is collegial, with a good deal of humor in evidence. I believe visitors would also note that students are willing and able to take intellectual risks, and to take on a variety of leadership roles.

**Leah Jamieson—
Purdue University
2001 NSF DTS Award**

- ◆ What I hope they would leave with is a sense of learning by doing, the opportunity to deeply engage with exciting projects, and a sense of ownership.
- ◆ Engineers have a bigger opportunity in this area. There has been a big gap between the perception of what engineers do and the social awareness of engineering. Engineering and community involvement are words not often used in the same sentence. But the idea that engineers make things that help people—this is a powerful concept.

**Eric Mazur—
Harvard University
2001 NSF DTS Award**

- ◆ I have a lot of visitors come into my classroom, often a delegation from another college or university. What they see, I think, is great enthusiasm— perhaps even chaos. They will see that the ball is not in my court, that I teach by questioning rather than by talking.

This method of stimulating students to think can give a rather chaotic impression, but the students are thinking for themselves, rather than just transcribing what I might be thinking— or just starrng into infinity and not thinking at all. What we are about is using a strategy called “peer instruction,” incorporating cooperative learning exercises into otherwise traditional lectures.

- ◆ Many visitors leave ready to try this approach, and over the past ten years, more than 350 other instructors— in different settings and disciplines— have successfully adapted our work.

Even though people sometimes say, “this can work for Harvard, but not for us,” that is not the case. Students on campuses of all sizes and circumstances become eager to talk with each other, and we are finding that they can verbalize what they are learning better to their peers than to a seasoned instructor, who might be burdened by years of experience with being able to understand conceptual difficulties that students might be having.



IMPRESSIONS OF STUDENT LEARNING II

**Carl E. Wieman—
University of Colorado-Boulder
2001 NSF DTS Award**

- ♦ I am not sure what impression they would leave with, but I can say what impression I hope they would get. I would hope they would see a bunch of students interested in what they are learning and taking a lot of responsibility for figuring out physics and how it applies to the world around them.

I do know that, compared to many other physics classes I have observed, a far larger fraction of the students in my “lectures” are awake, paying attention, and asking questions, so I may not be hoping entirely in vain. ■