# MRS Featured Volunteer

**Alan Hurd**
*MRS Treasurer, 1997–1999*
*Public Outreach Subcommittee Chair (1999)*

***What is your favorite element?***
Chocolatium. Unfortunately it exhibits some evil chemistry in my body.

***What do you read first in* MRS Bulletin*?***
Posterminaries and history columns. When I'm frustrated with my job, Classified Ads.

***What was the last book you read?***
*Into Thin Air.*

***What inspired you to be a materials researcher?***
I never Aspired to do materials physics...but I am INspired to continue in it because of the exciting stuff going on in materials research. I intend to EXpire in the same track now that I've found it.

***What did you first do as an MRS volunteer?***
Taught a short course in the mid-80s. At some point I got roped into the Membership Committee—by Daryush Ila and David Sours.

***What is your Motto?***
I always say, "..!" Oops, can't print that.

***If you were not a materials researcher, what would you be?***
A tree. No, wait...an elm tree. Does this remind you of a Barbara Walters interview?
My ultimate goal is to open a coffee shop / book store in Aspen or Banff.

***What common household item do you use in your lab?***
Aluminum foil! Actually, my most unusual lab item is a set of dental tools (hand-me-downs from my dental hygienist sister) for moving stuff around under a microscope.

To contribute to **MRS Featured Volunteer**, send in your responses to the questions to *MRS Bulletin*, 506 Keystone Drive, Warrendale, PA 15086-7573, USA; fax 724-779-8313; e-mail Bulletin@mrs.org. Include your name, volunteer activity, address, fax, and e-mail.

## EDUCATION EXCHANGE

# Clear Expectations in Teaching: How to Help Students Read Your Mind

As college-level educators in materials science and engineering, I find that we must clarify for our students what we expect them to learn. This is more complicated than it sounds; we need to use strategies to communicate to students what is in our heads. They cannot read our minds, but they can read what we hand out to them about our expectations. I have found three strategies that accomplish this goal.

### Strategy #1: Learning Objectives

In my courses, using learning objectives (LOs) is a powerful tool to clarify my expectations. The most important step in the process is to properly construct these objectives, which is relatively straightforward to do. Each learning objective must be action-oriented, measurable, specific, relevant (to the course material), and organized (by some major or minor topic). Here are a few examples from a variety of courses:

- *Identify* the close-packed directions in fcc and bcc structures.
- *Classify* the defect structures in crystals according to dimension.
- *Predict* the relative activation energy value for diffusion in covalent crystals compared to metals.
- *Verify* that a certain phase transformation follows sigmoidal kinetics.
- *Apply* the concepts of surface energy to show why a polished polycrystalline sample etches preferentially at its grain boundaries.

The action-oriented verbs that begin each LO follow Bloom's taxonomy[1,2] for accessing different levels of learning (cognitive domain). For example, having a student produce a *list* of some aspects of materials properties or behavior is much different from having the student *predict* how materials will behave under certain circumstances. It is important that the set of LOs for a given topic encompasses the full range of the cognitive domain. I steer clear of words like "understand," "know," or "appreciate" because these are very difficult to measure. It can be time consuming to come up with these LOs, but the effort is well worth it. When I give these to my students, two results occur: (1) they have a clear idea of what specific things I want them to be able to do with the information I present in the course, and (2) they like the course much more because I am being "up front" with



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them about what I expect. My students spend less time trying to read my mind and more time working on achieving the learning objectives (which is what we want them to do anyway, right?).

## Strategy #2: Organization & Structure

Another strategy for communicating expectations is to get across our *organization* and *structure* for given topics in a course. This is more important than it first seems. From our faculty perspective, we know how certain concepts connect together or do not in a course. This is not particularly clear to our students, many of whom are probably seeing the material for the first time. Part of being an effective teacher is to give the students a lot of help with an organizational framework for the major and minor concepts in a course.

To produce the greatest impact, these organizational structures can take several forms. A good outline, as simple as it sounds, can help students organize topics and therefore concepts. What is even more powerful is some kind of graphical representation of these concepts. For example, Figure 1 illustrates one way to represent a lot of information on the mechanical behavior of materials with a graphical image.

Represented in Figure 1 are concepts associated with bonding and elastic deformation (atoms connected by a spring), dislocations, crystallographic slip and Schmid's law (the classic deforming cylinder diagram), and the overall stress-strain behavior of many engineering materials. Clearly, diagrams like this do not stand on their own; they need a lot of information to go with them. Here lies part of the beauty of graphical representations—they direct the student to much larger sets of information than can be conveyed verbally. My students said that these are very helpful to them in studying for exams, finding out areas where they need more information, and generally organizing their thoughts which greatly contributes to real learning. It appears that by letting my students know how I structure certain topics and concepts greatly aids them as they try to make sense of the topics for themselves.

## Strategy #3: End in Mind

A third way to communicate expectations to students is meant to address a fairly common student comment, "There must be some point to this, but I just don't see it!" We could be the best lecturers in the college, but if we do not give the proper context for the information, the proper endpoint, then there is a good chance our lecture may not go very far in helping students actually learn the material. So this particular strategy involves beginning with the *end in mind*.[3]

It is clear to us faculty why it is important to study solid-state diffusion or the defect structure of crystals. It is so inherently interesting to us that we cannot help but be enthralled by it. And we can envision students being sufficiently motivated to learn the material just because of its inherent appeal! True for faculty, but not for most students. We need to make strong connections for the students about *why* we need to study certain concepts or topics, and this connection needs to be made at the beginning of a topic. For example, solid-state diffusion is important because it can lead to doping semiconductors, carburizing steel, or sintering ceramic powders. Similarly, the *end in mind* for defect structures (i.e., the answer to why students need to study this) is to have a working knowledge of the electrical conductivity of semiconductors or the mechanical strength of engineering alloys. Doing something as simple as providing students with this insight at the beginning of the treatment of a topic is very powerful for getting the concepts across.

These three strategies have allowed me to make my expectations much clearer to my students. With these in hand, I hope to combine a great lecture experience along with a great learning experience for my students.

BLAIR LONDON

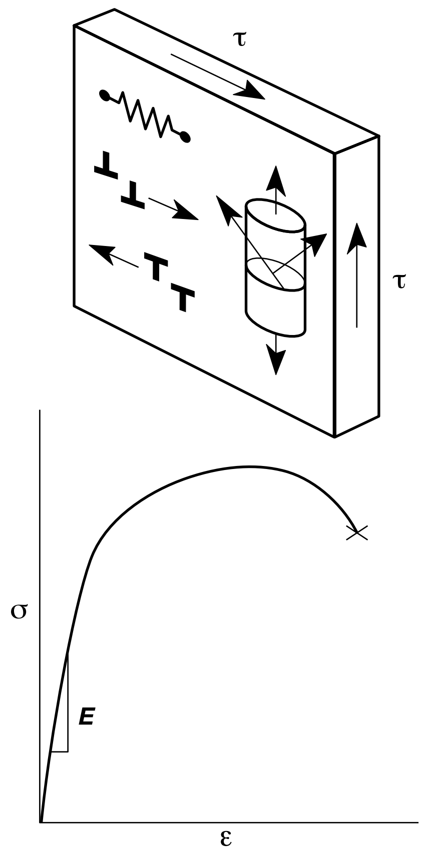


*Figure 1. Graphical representation of an introductory-level treatment of the mechanical properties of materials. The graphic is designed to summarize and organize a significant amount of information covered in part of a course. $\tau$ is sheer stress, $\sigma$ is normal stress, $\varepsilon$ is strain, and E is Young's Modulus.*

## References


1. B.S. Bloom, *Taxonomy of Educational Objectives Cognitive Domain* (Longman, New York, 1984).
2. J. Vargas, *Writing Worthwhile Behavioral Objectives* (Harper & Row, New York, 1972).
3. S.R. Covey, *The 7 Habits of Highly Effective People* (Simon & Schuster, New York, 1989).


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Education Exchange highlights experiences of scientists and engineers with local schools (K–12), community programs, and university programs, along with helpful hints and resources. If you would like to share your own involvement in science education, contact *MRS Bulletin*, Materials Research Society, 506 Keystone Drive, Warrendale, PA 15086-7573 USA; fax 724-779-8313; e-mail Bulletin@mrs.org.

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