Most people can maintain an attention span of eight minutes. Then the mind begins to wander. So why do teachers at all levels continue to drone on to rooms full of glassy-eyed students? Simple answer: That’s how most teachers are taught how to teach.

Grabbing Science

BY LINDSEY MICHAELS

Whack it, weigh it, poke it, prod it. Measure it and move it, scan it, heat it, cool it.

Spin it around. Electrify and magnify it. Push and pull it.

Grab onto a science education with both hands.
Imagine being seated on that plane. Or imagine members of the Phoenix Suns just talking about technique and strategy instead of really practicing and scrimmaging. What if your brain surgeon had only studied medicine in books? Sure you are ready for the operation to begin? Such scenarios are laughable. Our culture stresses hands-on experience above all else in nearly every situation. Every situation, it seems, except the education methodology and training of teachers.

The classroom situation is not so surprising if you consider the typical teaching method—teachers rely primarily on mind-numbing lectures to impart wisdom. After all, that is how they were taught.

Arizona State University professors Susan Wyckoff, Fred Staley, and Jim Mayer are just a few members of a multidisciplinary team dedicated to changing that antiquated system. Their rule: Replace droning lectures with hands-on interactive teaching, especially where topics such as mathematics and science are involved.

“For the United States to compete in a world where our labor costs are higher than those of economic rivals, survival depends on a scientifically literate work force,” explains Mayer, an accomplished scientist who directs a su’s Center for Solid State Science.

“To accomplish that, we must use a ‘hands-on’ teaching approach,” he continues. “We must give students a view of the world based on some reality that they can concretely deal with and manipulate. If not, math and science principles will remain just more meaningless statements that could be wrong, more irrelevant concepts that have no real role in life.”

Mayer is part of a university-wide project called the Arizona Collaboration in Preparation of Teachers (acept). acept’s goal involves teaching budding young teachers more about mathematics, science and technology. That accomplished, step two is to instruct them how to teach in more age-appropriate and stimulating ways.

acept team members are experts in all areas of mathematics, science, and education. The team’s first task is simple: Reform the courses required by all candidates for teaching certificates.

“We’re finally waking up after teaching the wrong way for years,” admits Susan Wyckoff, an astronomy professor and acept leader.

“People have only about an eight-minute attention span. We know that after eight minutes, minds wander,” she says. “Yet, we’ve continued lecturing to glassy-eyed students simply because that’s the way we were taught. From now on, our instruction actively incorporates hands-on and significant research which is clearly relevant to daily life.”

For example, Wyckoff now teaches her Introduction to Physical Sciences class using 77 networked computer stations and student “science kits.” She initially assists while students, working in small groups, discover things on their own.

Groups of students enter individual findings into a computer station, which instantly collates and displays class results. Wyckoff says she uses those results to stimulate discussion rather than just lecturing.

“There’s a tremendous body of knowledge to suggest that involving all five senses in the learning process results in simultaneous messages being sent to several areas of the brain,” Fred Staley says.

Staley is a professor of education. He has long studied the process of science education. “Presented with such multiple sensations, the brain becomes ‘alive’ and ‘engaged,’” opening multiple pathways to the limbic system,” he explains.

The limbic system is where emotion resides in the human brain. According to Staley, stimulating the limbic system provides two major positives. First, the brain stores emotional experiences in long-term, rather than short-term memory. Second, interactive experiences, which tend to stimulate such emotion, usually involve all five senses.

Lectures typically stimulate just one or two senses—sight and/or sound.

The end result? Interactive sensory stimulation typically forges five life-long learning links. Lecture formats often trigger only two passive links that fade away once the lecture is complete.

Not convinced? Picture your wide-eyed, 16-year-old with freshly minted driver’s license in hand. He wants to take your car. You know he successfully completed drivers’ education class. You know he scored a perfect 100 percent on his written driving test.

Despite all of his self confidence, you also know that he is still just a babe in the woods when it comes to the driving game.

He simply lacks important hands-on experience and related critical thinking and judgment skills. For example: What to do when it suddenly rains or a tire blows. How to calculate whether he can really make that left turn in the face of on-coming car traffic. How to juggle a 64-ounce Thirstbuster or Big Gulp while shifting gears.
key phases: Exploration, Term
demonstrations of weather concepts.

ASU geographer Randall Cerveny often visits local schools to give hands-on
Each phase is patterned after
Introduction, and Application.
method breaks learning into three
interactive way of teaching. The
has refined and championed.
Learning Cycles teaching method he
process. It is the basis for the

Cycles of Learning: A Case for Interactive Teaching

Think of effective learning as a
science experiment, with you as
the scientist. You become
vaguely aware of something. Start
tinkering with it. Discuss what you
saw occur. Refine your guesses.
Then test your new theory.
Anton Lawson practices the
process. It is the basis for the
Learning Cycles teaching method he
has refined and championed.

Learning Cycles is a highly
interactive way of teaching. The
method breaks learning into three
key phases: Exploration, Term
Introduction, and Application.
Each phase is patterned after
methods used in actual research.

Students then proceed to con-
duct hands-on research, using real
materials. The idea is to have stu-
dents look for patterns and begin to
wonder how, why, and how often
each thing occurs.
Lawson calls this the "Don't tell-
experiment" phase. He warns that
the exploration process can be
ruined if the teacher asks questions
that are too specific at the start. He
also warns that teachers using this
technique must know more—not
less—about both teaching and their
subjects. Classes and guesses can
move many ways quickly.

Once general patterns are
observed, teachers should bring
their students back together for
phase two. That's Term Introduction.
Term Introduction is the point
at which general patterns are dis-
cussed and observations named.
Terms such as normal distribution,
bell curve, and hypothesis should
be introduced.

Discussions eventually lead to
questions like: "Where else do we
find this pattern?" Or, "How many
people in each height group would
you expect to find campuswide?"

It is at this point that students
enter the Application Phase.

Students test their assumptions
by extending them to other
things and situations.

For example, Does what
I first observed hold true
over many trials? Does the
normal distribution process
I observed in human sizes apply
to the size of leaves as well?

"To be a really good
problem solver in class- and life-
you need to be able to take lots
of facts and make sense of them,"
Lawson says. "You must learn
to think, not just memorize."

Lawson says that results from
scientific research consistently
confirm that interactive teaching is
much more effective than lecturing
for preparing kids for life.

"Ultimately, people will be divided
into one of two categories: people
who think and people who don't,"
Lawson says. "The people who
think will be more skeptical, better
able to problem solve, and more
competitive than those who blindly
follow rules."—Lindsey Michaels

For more information about Cycles
of Learning, contact Anton Lawson,
Ph.D., Department of Zoology,
602.965.2540.
The Patterns in Nature van is a rolling, fully equipped science laboratory. A student builds and readies it for launch, creating an Internet address on the www. The van serves as a free, traveling classroom for current students and their teachers. There are other interactive AISE programs aimed at young students. These include Women In Science and Engineering (WISE) and the Center for Academic Precocity (CAP).

WISE introduces high school age girls to the truly exciting aspects of science. Each girl spends several summer days on campus building rockets, viewing comets or atoms, and working on a variety of experiments. CAP provides kindergarten through high school children real-life science experience. Each summer, over 650 young students spend 20 days “playing” in age-appropriate computer, biology, physics, video production, and mathematics classes. CAP also offers evening and weekend classes throughout the year.

ASU graduate and undergraduate science students staff the Patterns in Nature van. Clockwise from left front: Marc Castagna, Andy Mayer, Eric Palmer, Michael Mayer, and Steve Beeson.

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CEPT is supported by a $5 million grant from the National Science Foundation. For more information about the project, contact Susan Wyckoff, Ph.D., Department of Physics and Astronomy, College of Liberal Arts and Sciences, 602.965.3561, or Frederick Staley, Ph.D., Curriculum and Instruction, College of Education, 602.965.3133. For more information about Patterns in Nature, call 602.965.9200; about WISE, call 602.965.6882; about CAP, call 602.965.4757.

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