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Oh, Science . . . Ah, Science

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Thank you, President Metzner, for the kind introduction. It is very good to be at Northern at my alma mater. Several years ago when Harold Foss, of the Nominating Committee, asked me if I would stand for election, I never dreamed that this day would ever come. Now I am scared to death and somewhat choked up, but looking forward to a year of leadership opportunities. I thought of a lot of topics but finally decided upon this one which you might not recognize but it is a continuation of Steve's talk of last year. I hope Steve recognizes that it is a continuation.

What happens when someone asks what you do and you respond, "I teach science."? Do you often get the dwindling reply, "Oooh, Science."? Don't you become enthused when someone replies, "Ah, Science."? The tone of the reply makes a difference to you.

Have you had occasion to overhear students talking about their classes? What do you infer from a reply of "Oh, Science."? "Ah, Science."? Very often the reply of "Oh" is an expression of fear and a dislike of science or an indication of previous difficulties. While "A" expresses enthusiasm and interest in the subject.

As you visit with your pupils, can you tell who are the "Oh" and the "Ah" students? I observe that the Ahs have a different mindset. They are optimistic, unfrightened, anticipatory, and active learners. The same is true of adult "Ahs."

DEVELOPING AHS

What can we do to develop a society of Ahs? They will be much better supporters of the funding of science and more supportive parents and patrons of schools and higher education. They will be more resonant to our noises concerning science when they serve as school board and Board of Regent members or as legislators or governors or as administrators of our programs.

My thesis is that we need to exert much more effort to improve the image of science. All of us think, "Science is Fun." At least, I hope that you do or I would want you to find another vocation. You are part of the problem if you are not part of the solution. I didn't say that you thought that science was frivolous or easy or entertaining for entertainment's sake. I did imply that you thought science was exciting, inspiring, and caused you to be a lifelong learner. It is somewhat like adrenalin or your favorite ice cream sundae. We are enthused. We're Ah, Science people.

LOCAL EVIDENCE

What evidence do we have in South Dakota of Ah and Oh? Board of Regents' institutions' budgets are cut. Programs are cut or eliminated. Staff is cut. South Dakota is last in teacher pay in the nation. Equipment purchases are delayed. School boards hold the line on salaries and instructional material purchases. Texts are used another year. Computers, interfacing equipment, and software are not purchased. There are no S D student winners in the Westinghouse Science Talent Search again this year. No science research programs for S D high school students are available for summer work for students. Teachers encounter difficulties obtaining leave to take students to participate in Junior Academy, Science Fair, Science Olympiad, and Impact '87. Science teachers aren't provided the same funds as other activities—I refer to music, athletics, and speech. Teachers have to beg to go to in-service sessions. The State Board's desire to reduce teacher's time out of the classroom is used to suppress participation in spite of the availability of funds from Title II of the Education for Economic Security Act. But, there are Ahs! Science Fairs continue to grow. Science Olympiad is growing. S D students qualify for prestigious colleges and are granted academic scholarships. S D college graduates readily gain acceptance into graduate schools. S D college graduates are courted as prospective employees. College faculty maintain an interest in pre-college programs and provide leadership for in-service for teachers and for student programs. There is optimism.

THE SOLUTION

It almost sounds like the entropy dilemma, doesn't it? "No sense worrying, nothing is going to turn out alright." There is considerable evidence of degradation to disorder and chaos. It is reminiscent of the mess that I call my desk and carrel and classroom. But, as in entropy, there is a ray of hope. Energy can be used to set the room in order and to straighten out my desk. Energy can be used to put systems in order rather than allowing them to resort to randomness. Likewise, we can put science in order in

South Dakota. We have energy. We can analyze the problem and correct it by offering alternatives. Pessimism doesn't need to rule. Optimism can supplant it.

What can be done? It seems as if three areas merit our attention. I am a teacher and proud of it. I expect that all of you are also proud to be teachers. And all of you teach. Some of you teach more than others, but teaching is what most of you were hired to do. The areas are curriculum, teacher behavior, and classroom activities.

CURRICULUM

What should we study? The continual cry is for relevance and excellence. The recently enacted State Board of Education rules that mandate more science for every student creates some problems.

In spite of the edicts that mandate physics, chemistry, and biology, it seems sensible to offer courses that are Science/Technology/Society oriented. The purpose of such instruction would be to prepare students to be effective, contributing, productive citizens. There is a need for S/T/S instruction. Nearly half the bills before the U S Congress have a substantial science-technology component. As citizens in training students need to have a background in relevant issues to enable them to make informed decisions. An educated laymen needs knowledge and understanding necessary to participate in decision-making or citizens will abrogate the responsibility to a "priestly elite" who, it is hoped, will be wise and benevolent. That is not a participatory democracy. Without control or meaningful input, there is slavery.

Presently the people who run the country and the state are managers of people, not things. These nonscientists, the lawyers and MBA's, need to be educated in science.

Our task, as the leaders in S D science, is to convince the public that science is comprehensible. We must get them to comprehend *some* science that infringes on the lives of the students, S/T/S. Then, they are more likely to attend long enough and intensely to comprehend. For the past two years I've been afforded the opportunity to be one of the Field Trial teachers for CEPUP, Chemical Education for Public Understanding Project. There are six of us who work through an NSTA committee. The project is funded by California Industrial Foundations and is developed by the Lawrence Hall of Science in Berkeley. It is one of the S/T/S courses now being made available. It is hands-on. Students find it very interesting and informative. The content is chemical pollution, acid rain, threshold limits, and risk taking. It is an Ah.

One of the features is a course without an extensive vocabulary. There are science words but not the 6,000 new words found in a typical secondary school science course. That many words turns off learners and is a definite Ooh!

There is some math but not problems for problems' sake. The understanding of a concrete ppm is thus an Ah! rather than the customary Ooh! that greets a story problem.

The textbook alone is not science or the curriculum. Science and scientists cannot be isolationists. Local conditions, store shelves, newspapers, magazines, people, and TV are references and lessons. Students learn that education does not end with graduation. They accept that they need to be lifelong learners.

However, relevance is not a substitute for substance in the education of American citizens. Hubert Alyea, Princeton chemist, often states "Who knows what will be relevant? The trivia of today becomes relevant tomorrow." As Albert Einstein has stated, "God is subtle, but never malicious."

Bob Yager and his science education colleagues at the University of Iowa have found in their research that excellent teachers use societal issues as a focus. Look for materials being developed in Pennsylvania by Rustrum Roy; at Wausau, Wisconsin; in Florida; and at Lawrence Hall in California. Incorporate them into your teaching. Assist your students to become effective citizens and get more Ahs.

CLASSROOM ACTIVITIES

There have been many statements made that can provide direction for what we do in the classroom, in our own castle. Faraday quipped that to make a fact his own, he had to see it. Aristotle observed that the soul never thinks without an image. Roger Bacon stated that all knowledge begins with observation. Yogi Berra, now a Houston Astros coach, succinctly put it that you can learn a lot by just watching. Science is not a spectator sport. Ernest Rutherford lamented that he felt sorry for the humanists. They had no lab to work in and to learn from.

Science is two things, a body of knowledge and a process of investigation. There is too much to know in science. The teacher is the catalyst in the educational process. We can't make students learn but we provide opportunities to learn and illustrate an example of a learner. People must educate themselves. Abraham Lincoln profoundly emphasized that you can't help a man permanently by doing for him something he can do for himself.

Again, we can't teach students all that they need to know. The student must establish an intellectual individuality. We don't learn the language of science from formal definition. No concept is so simple, however that it can't be misunderstood. G. K. Chesterton deduced that it isn't that students can't see the solution or the concept. It is rather that they haven't seen the problem.

We need to get students to not ask "What do you want me to do?" They need the intellectual maturity not to play games of school. School is not preparation for life; it is the child's life at that moment. Children need to get their questions answered, sometimes by us and sometimes by others. But, they need answers or they become disenchanting. But, we can't answer with an absolute authority. That implies the students must learn what we know.

The classroom activities also need to provide an opportunity to fail. Failing is part of life. It hurts, but we need to learn to live with it. We must provide an accepting environment. Not one that doesn't have rewards and punishment but an environment that provides an opportunity to learn from failure and strive to be a winner rather than a pouter. Roger Bacon concluded that truth emerges more readily from error than confusion. Bertrand Russell noted that not to be absolutely certain is one of the essential things of rationality.

"This" is the most important word that we use. It brings Ahs! We demonstrate "this." We work on "this." We observe and process "this." We remember "this." Science doesn't prescribe, it describes. The person who remembers nothing thinks about nothing.

We can't be too concerned with the past. We need to study it and learn from it. The past is like the rear view mirror in your automobile when it is compared to the windshield. The windshield is much larger. We look out the windshield and only occasionally use the mirror. Thus, we focus on the future but are cognizant of the past.

We've been studying equilibria in class the last several weeks. Some of my students, believe it or not, aren't doing their homework. They watch others do it and then copy it. I began class one day by stating that I'd resigned and was going to join the Boston Celtics as a player. They looked even more startled than you. I told them I'd been reading all about the Celtics, their players, and basketball. I'd watched TV games. I knew all there was to know! So, off I was going to be a professional basketball player. They countered that it took more than that. Some red faces and sheepish looks appeared as the message hit home. New efforts resulted. It was an Ah!

THE TEACHER

Let us now turn our attention to the most important model, the teacher. Teaching is person-to-person communication that is not so much information, please as inspiration, please. Even if we wanted to, we could not avoid influencing the character of our students as we teach and work with them.

What do good teachers do? Ron Bonstetter, now at Nebraska but formerly at Iowa with Bob Yager, found from the results of responses from Search for Excellence in Science Education winning teachers that excellent teachers are workaholics; they are active in the school and community and in local, state, and national professional societies; and they were discontented with their already excellent programs and wanted even better programs.

Winning teachers *want to be excellent* and are willing to pay the price. They are self-correcting and attend many voluntary in-service sessions. Yager found that amazingly preparation in science content courses is *not* a variable. This causes us to question the S D and national increase in certification standards. Rather, motivation is critical. Benjamin Bloom also learned that natural talent is less of a factor than hard work and persistence. This came from a study of excellent performers in a wide range of fields. John Penick, also of Iowa, found that excellent teachers have high expectations and put in far more than minimal time.

Each year at the sessions for the Presidential Award in Science and Mathematics Teaching, Bassam Shakishiri, formerly at the U of Wisconsin Chemistry Department but now NSF Associate Director, presents his mix of chemical demonstrations and teaching philosophy in the form of the 4 C's that he considers the essence of teaching. They are:

1. Competent in Your Discipline
2. Committed to Your Profession
3. Comfortable in Your Methods
4. Caring for Your Students

How do we do this? Excellent science teachers are collectors. But it is often not a neat collection. They are like museum curators. They challenge students academically. Students are much more unlike after being in class than all leaving from one mold. Individual differences are accepted and utilized. They are able to accept the criticism of a demanding teacher.

One of the "Ohs" is to be able to overcome the frustration of working with one's own colleagues and not being an influence upon them. You are recognized last at home!

Teachers learn to promise nothing and make everything possible. Paradoxes and discrepant events are often the vehicle of motivation to provide Piaget's cognitive dissonance to initiate self-learning. Adolescence can be a very turbulent time. Sometimes teenagers seem to be a pulsating mass of misunderstood glands. They don't get excited by a discussion of pollution but by a teacher. *Teachers teach.* What do you remember of your best teachers? Likely it is a caring, dedicated person who did not give up on you. Probably there were some eccentricities and a lot of stories. I recall the many human stories of scientists like Kepler, Rumford, Galileo, Mendel, and Lavossier, told by USD's Dr. Driscoll at hot, long NSF summer institute seminars that kept all interested. Teachers are salesmen whose ware is intellectual curiosity.

SUMMARY

Let us all be challenged to produce Ahs. Let's try out a new mindset. Leon Lederman, Fermi Lab Director, tells the conversation of a student and a math teacher:

Math Teacher: "How much is 2.5 times 2?"

Johnny: "Five."

Teacher: "That's good!"

Johnny: "What do you mean good? It's perfect!"

Imagine that the glass is half full instead of half empty. Instead of fixating on "if only the people out there were more rational and/or more capable," start instead with a premise of how good they already are. Most of us are typical teachers working with typical students in typical schools. It is this group that we are not impacting who are our clientele and our patrons. We know how to do this so much better than we are now doing. We need an infrastructure to support improvement, innovation and renewal. It is not there in South Dakota or the United States. Until we get it, we are not going to make quantum leaps of progress and transform our schools into Ahs.

We need to make the public and the policy makers aware of the long-term implications and dangers associated with poor science and mathematics education. Demanding improvement does not necessarily imply negative criticism of the current status as being all wrong or all bad. It is only that change is needed. Those changes are in the curriculum, classroom activities, and in the caring teacher.

Once upon a time there were four S D Academy of Science members named *Everybody*, *Somebody*, *Nobody* and *Anybody*. When there was an important job to be done, *Everybody* was asked to do

it. *Everybody* was sure that *Somebody* would do it. *Anybody* could have done it, but *Nobody* did it.

When *Nobody* did it, *Somebody* got angry because it was *Everybody's* job. *Everybody* thought *Somebody* would do it, but *Nobody* did.

So it ended up that *Everybody* blamed *Somebody* when *Nobody* did what *Anybody* could have done in the first place!

All of us have to be one of the Bodys. Let us do our part to get the job done and to produce Ahs. Maybe some of you are old enough to remember the lyrics "Accentuate the Positive and Eliminate the Negatives." Let's accentuate the Ahs and eliminate the Ohs!

Thank you for your kind attention to some thoughts that concern me.