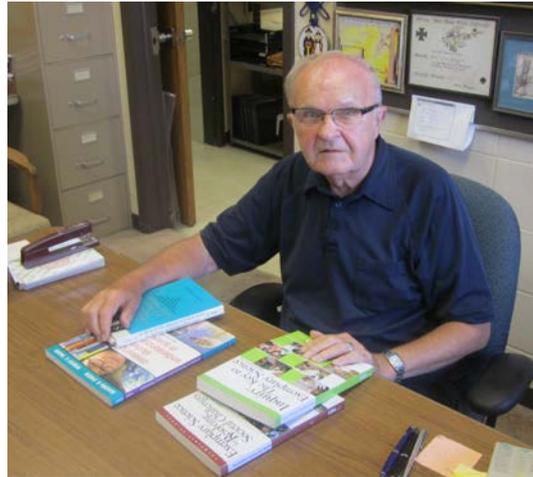


## Interview with Science Education Pioneer Bob Yager

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Having started his career as a high school science teacher, Robert E. Yager has been a professor of science education at the University of Iowa since 1956. A prominent voice in science education, he has served as president of several national organizations, including NSTA, School Science and Mathematics Association, National Association of Biology Teachers, Association for the Education of Teachers in Science, National Association for Research in Science Teaching and National Association for Science, Technology and Society. Dr. Yager has been involved in teacher education in the U.S. and many European and Asian countries for nearly 60 years. Among his many publications are several NSTA books, including *Focus on Excellence* and two issues of *What Research Says to the Science Teacher*. He has authored over 700 research and policy publications as well as having served as editor for ten volumes of NSTA's Exemplary Science Programs (ESP). Dr. Yager earned a bachelor's degree in biology from the University of Northern Iowa and master's and doctoral degrees in plant physiology from the University of Iowa.



*Robert E. Yager*

In a recent interview, Dr. Yager spoke about his participation in the changing field of science education, the challenges that still persist in implementing exemplary science teaching, STEM Education and his views on the current science education standards.

**You have been involved in science education for nearly 60 years. What was the general attitude about school science when you started in the late 1950's and in the 1960's?**

Science was and is a major part of K-12 curricula, especially at the high school level, but few then saw a relationship of science to the general lives of all.

**It seems that science education has been evolving ever since. What have the major trends been and where do you see science education going from here?**

Major trends include science in the news, e.g., health, space, atom bomb, etc. I see school science changing radically with the appearance of STEM.

**Explain how the STEM movement has brought radical changes in school science.**

It has caused people to view differently what science really is. STEM curricula have not occurred all over the world but more people are investigating it. Sometimes major funding has encouraged more educators and researchers to accomplish what STEM is trying to do. It certainly is more activity-based and student-centered than with any other reform efforts over the past decades. A good example of early STEM

efforts is *Science for All Americans – Project 2061* as a major reform. In retrospect it seems amazing what the idea of STEM has promoted in less than 75 years which was the aim suggested by Project 2061, even though not necessarily under the STEM label.

**You have been one of the most influential voices in science education for most of your career, with over 700 published works, president of many science education organizations, several books and lately a series on exemplary science teaching for the National Science Teachers Association. What has been the driving force that has made you so prolific?**

Seeing real changes as the result of student learning. Looking back, it has been interesting to see the extent of errors in the interpretations of science throughout the years. I particularly like the quotes at [www.rinkworks.com/said/predictions.shtml](http://www.rinkworks.com/said/predictions.shtml)

- (Example: "There is not the slightest indication that nuclear energy will ever be obtainable. It would mean that the atom would have to be shattered at will." – *Albert Einstein, 1932.*)

**You have long championed “S-T-S” (Science, Technology and Society) as an approach to teaching and learning science. How did that come about?**

Rustum Roy, Professor of Geochemistry at Pennsylvania State University, was the champion of the term STS. E. Joseph Piel of the State University of New York at Stony Brook helped Roy define STS. It was an example of making science education a “science” itself and used to introduce debates among students. Piel used daily newspapers as a source for asking questions that were personal, current, and a social issue. It eliminated science as defined in textbooks and laboratory manuals. It made science more personal. Personally “doing” real science in classrooms resulted in many student debates. For example (a former) director of NSTA liked to argue that STS meant “**S**top **T**eaching **S**cience”.

**How would you define STS and its goal?**

In the early 80’s I wrote many articles and chapters about STS as a reform movement in which I identified the following strands: STS means focusing on science concepts and process skills that are useful in the daily living of students; focusing on societal issues in homes, schools, and communities as well as the more global problems that should concern all humankind. Finally, STS also means focusing on the occupations and careers that are known today by using human resources in identifying and resolving local issues. Its goal was to provide a method to answer NSTA’s challenge of developing scientifically literate individuals who knew how to use problem solving in every day living.

**Would you say that STS was a forerunner of STEM?**

Yes, I would. STS personalized science, and STEM focuses on solving problems in everyday situations. The name isn’t important; it’s what you are trying to do that is important.

**You recently wrote a chapter for a book edited by Samuel Totten, *The Importance of Teaching Social Issues: Our Pedagogical Creeds*. In it, you note that the key point in your creed is that of a student-centered classroom. You have been advocating that for some time. How much a part of U.S. school curricula do you think it is now?**

This is a guess but I do not feel that the race for change has even affected 50% of science teachers.

**Why do you think there is such a hesitancy to embrace effective science teaching methodology?**

The major problem is the use of college science teaching as a model. This emphasizes the problem; most college science teaching is merely presenting information produced by practicing scientists. If you're a good memorizer, you do well in college science courses. I was one, and I did well!

**What was the greatest influence in the development of your creed?**

It is tough to single out one, but as I pondered the question I feel that Project Synthesis has affected me the most. My first full analysis of Project Synthesis was an article I wrote with N. C. Harms in *What Research Says to the Science Teacher, Volume 3*, published by the National Science Teachers Association

**What was it about Project Synthesis that had such a profound affect?**

Basically it was the people that made up the research team, especially Paul DeHart Hurd of Stanford University. Hurd reminded us in Project Synthesis research that only 0.000059% of all humans across the world are actually "practicing" scientists. I also worked closely with Rodger Bybee and Jane Kahle in their research as part of the Synthesis efforts. Most college science teachers do not place a high value on teaching compared to their science research. Research is more important in terms of salary, promotion, and success. Teaching is merely something they have to do to justify being a professor. College science teachers do not consider being good teachers as being something of value. Bruce Alberts (a scientist, employee of the National Science Foundation, and recent editor of AAAS weekly *Science* journal) offered this as one of the problematic situations for education, i.e., the improvement of college science teaching. Even as recently as January 2015, Alan I. Leshner, Chief Executive Officer of AAAS stated in an editorial in *Science*, "Speaking up for the importance of science to society is our only hope to improve education."

**You mention several science philosophers in the recent chapter. Did anyone in particular have an effect that became part of your creed?**

George Cossman was one of my first students who became interested in science philosophy. Even as a high school physics teacher his interest in history and philosophy of science became an important ingredient and central to our Science Education Program here at the University of Iowa. I even learned more about the nature of science from George than from all the textbooks and lectures I had taken to earn my degrees.

**What do you see as the major challenges for advancing exemplary science teaching and learning in the United States?**

Getting most college science teachers to change from lectures and associated "directed" laboratories will not be easy. Instead, they should be illustrating the actual "doing" of science.

**Apparently, that has been a difficult challenge. College students even today will tell you that it is not common. Why is that?**

Until universities start focusing more on student learning and improved teaching as opposed to doing scientific research, we will continue to have major problems.

Universities like professors to prepare research manuscripts that have nothing to do with the improvement of teaching. College science instructors continue to be poor models for getting student to experience real science.

**The University of Iowa, where you have spent your entire career, was one of the major centers of science education research and initiatives in the 70's, 80's and 90's with you and several other influential science educators. Describe the environment of the science education department at Iowa during that time.**

The strength of the University of Iowa Science Education Program was the different ideas and philosophies of faculty members and their personal experiences with science. At its peak, the program at Iowa involved 11 faculty members with varying philosophies. With up to 70 or so graduate students, it was a very rich and creative place with a fertile environment for science education reform.

**It must be very satisfying to now see so many former graduate students playing major roles in science education all over the United States and other countries.**

It is certainly very rewarding and I am humbled by it.

**What do you consider your greatest achievement in, or contribution to science education?**

Defining science as *"the exploration of the natural universe seeking explanations of the objects and events encountered"*. I contributed to the National Science Teachers Association (NSTA) efforts in this regard.

**You are still editing and writing. Do you ever plan to stop?**

I do not plan to stop but it becomes more difficult with poorer penmanship, health issues, and is more time consuming to deal with international students, politics, and missing the point of the effectiveness of the so-called Science Standards.

**What do you see as the problem with the current Science Standards?**

"Achieve" was a group consisting of 41 members who led the Next Generation Science Standards (NGSS) efforts. My criticism of the effort is that Achieve members decided not to focus on teaching; instead they spent time dealing with "Crosscutting Concepts", i.e., information accepted by scientists. They were concerned with Core Ideas related to the four disciplines (biology, chemistry, physics, and earth science). The exploration of the natural world and universe are not ideas offered in the NGSS. STEM is an effort to try to correct these problems.

Even the term "inquiry" was not liked by the NGSS authors because they thought that no one really understood what it meant. To me, this omits the very meaning of science. It omits what science should be. Science doesn't like "followers"; it likes "innovators" and "doers". I find it upsetting that every current NSTA publication has to cite NGSS just to indicate the NGSS reforms.

**Where does STEM fit in?**

There is more to be gained from STEM other than "that's where the money is". In other words it is important and not merely a way to get funding. But it has much to offer in the ways of "doing" science (the exploration of the natural world seeking explanations for the objects and events encountered). Why not take advantage of the enthusiasm it has generated instead of turning out more publications regarding their (faculty) science research?

**What advice would you give to anyone who wants to be a science teacher?**

Welcome learning. Share questions – realize we do not yet know it all. Be a model learner and not a theologian. By theologian I mean someone who finds comfort in remembering what is included in textbooks.

Teachers are the key. Involve the students in the learning process, not just change the curriculum. Use what we know from the studies of exemplary science teaching and assessing student learning to reform STEM education:

- 1) Work with students concerning their interests and ideas.
- 2) Encourage students to work as partners and teams dealing with questions in groups of two to four students.
- 3) Focus on student questions and issues with activities that are local, current, and personal.
- 4) Understand and respond to individual student interests, strengths, experiences, and needs.
- 5) Focus on student understandings and use of information, ideas, and inquiry processes.
- 6) Guide students for working in groups with active and extended inquiries.
- 7) Provide opportunities for discussion and debate among students.
- 8) Share responsibilities for learning with students.
- 9) Support classroom communities with cooperation and respect.
- 10) Work with other teachers to enhance the whole school STEM program.

If every STEM teacher did this, it would result in great benefits for their students, and society as a whole.



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