

New Hydrogen Outreach Program for Education (New HOPE): an American Case Study

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New Hydrogen Outreach Program for Education (New HOPE): An American Case Study

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1 Introduction

From 2006-2008, the progressive and committed New York team consisting of the New York Energy Research Development Authority (NYSERDA), the New York Power Authority (NYPA) and the Long Island Power Authority (LIPA) supported delivery of New HOPE (Hydrogen Outreach Program for Education) teacher training workshops to over 300 New York State high school science and technology teachers. These teachers will impact some 150,000 students over the next five years.

The teacher training was developed and delivered by M.R.S. Enterprises, LLC and its HOPE team. Training occurred in full day workshops that featured hands-on activities, including construction of a fuel cell vehicle from everyday materials. Workshop topics spanned the full range of learning in hydrogen production, storage, distribution and utilization, as well as fuel cells. Participating teachers received the New HOPE Pilot TM, a user friendly curriculum with one-day, one-week and enrichment lesson plans. They also received two companion videos and two kits for classroom use.

This American case study in hydrogen outreach features valuable lessons learned that can contribute to your near-term hydrogen and fuel cell education and teacher training efforts, as well as the larger transition to a hydrogen-oriented society.

2 The Challenge

There is widespread agreement that lack of education is a barrier to introduction and advancement of hydrogen in the economy. Today's teachers and their students -- tomorrow's consumers and citizens -- are clearly essential to our energy future. Experience suggests that one of the best ways to reach students is through their teachers. As a vehicle for technology transfer, it is the teachers who will educate students in hydrogen science and technology. But who will teach the teachers and how will the training be delivered?

3 The New York State Response

In the United States, New York State provides energy education through its Energy Smart Students Program. New York State has developed a Hydrogen Roadmap that features outreach and education because this state recognizes that lack of education is a barrier to introduction and advancement of hydrogen. New York State's hydrogen energy solution is called The New HOPE Pilot: the Hydrogen Outreach Program for Education.

The original M.R.S. HOPE Pilot TM, chartered by the U.S. DOE, was developed to teacher secondary students about the potential and benefits of hydrogen as a fuel and energy carrier. It is available in two versions, one for high school students (14-18 years of age) and the other for middle school students (12-14 years of age). Both are integrated student/teacher curricula

organized in modules that consist of several lessons. The 75 lesson high school curriculum consists of seven modules while the 30 lesson middle school curriculum is organized in five modules. Two videos are distributed with the curricula.

However, NYSERDA preferred a more compact edition of the curriculum targeted specifically to either a “one-day” or “one-week” hydrogen program for the classroom or an after-school program. Consequently, the New HOPE Pilot TM was excerpted from the original HOPE Pilot to meet these requirements. Furthermore, NYSERDA decided to target two teacher groups, science teachers and technology teachers. Therefore, two versions of the New HOPE Pilot TM were developed, one for science teachers and the other for technology teachers. In addition to being correlated with the National Science Standards, all New HOPE Pilot TM content is correlated with the New York State Math, Science and Technology (MST) standards. The science version is also correlated with the New York State “ChemCore Guide Concepts” that were formulated to better prepare students for the New York State Regent’s Examination. Lesson plans were developed for both the nominal “one-day” and “one-week” hydrogen program for the classroom as well as an after-school program.

4 The New HOPE Product

The Teacher Training giveaways included: curriculum, lesson plans, a video (renewable Power – Earth’s Clean Energy Destiny) although Hydrogen – the Pollution Solution was used in the classroom; an Intelligent Car Kit and Experiment Manual for all teachers; HOPEmobile kits (with everyday materials to take back to the classroom).

5 The New HOPE Pilot Teacher Training Workshop

The New HOPE Pilot workshop experience is a full-day affair. It begins at 8 or 9 and continues until 3:30. The format features a mixture of lecture, demonstrations and “hands-on” inquiry based activities. It includes hospitality (continental breakfast and lunch), evaluations and giveaways.

6 The New HOPE Team

The New HOPE team consists of three experts in hydrogen and fuel cells, and technology education: Mary-Rose de Valladares, Ken Kenyon and Ernie Ruiz. The HOPE team’s professional expertise cross-cuts hydrogen science, engineering, business and education.

7 Lessons Learned

This entire New HOPE teacher training process has been a continuous learning and a continuous improvement experience. The lessons learned from the New HOPE American case study are presented here for the benefit of hydrogen educators everywhere. The lessons learned are divided into four categories: Content; Approach; Supply Chain Logistics and the Delivery of Learning; and Learning Style and Participation.

7.1 Lessons learned: Content

Hydrogen 101

The bottom line here is science and technology. NYSERDA and its partners asked M.R.S. to deliver hydrogen “101,” which includes all the basics of production, storage, distribution, safety and utilization. It also includes all the fuel cell basics, meaning principles of fuel cells, types of fuel cells and uses of fuel cells. This strategy proved effective: hydrogen educators should focus first on delivering the hydrogen and fuel cell basics.

The Role of Standards

The New HOPE Pilot curriculum is related to the national American science standards and the applicable New York state standards. For New York State, this meant correlating lessons to the “Chem Core” that govern material covered by the New York Regent’s examination as well as state standards applicable to Math, Science and Technology. Correlation of learning material to national and state standards is clearly a best practice.

Differentiation by Target Group and Interdisciplinary Content

As previously explained, the New HOPE Pilot curricula are also differentiated to meet the needs of NYSERDA’s two target groups, science and technology teachers. Every effort is made to gear the training to classroom realities for both science and technology teachers. Hydrogen educators should understand the needs of their target audiences and teach accordingly.

Irrespective of the target audience, hydrogen educators should be aware that the need for interdisciplinary content that goes beyond science and technology. With New HOPE Pilot training, M.R.S. provides an interdisciplinary training experience that puts considerable emphasis on the non-science areas. To adequately prepare teachers, hydrogen educators will have to provide non-science content in teacher training.

“Takeaways”: Tools and Materials for Future Use in the Classroom

In order to enable teachers to utilize their training it is essential to provide tools – curricula, lesson plans, materials and kits collectively referred to as “takeaways” --- which they can take back to classroom and use. By providing takeaways, hydrogen educators have the assurance that teachers possess the tools necessary to institute a program/unit in classroom. Optimally, the takeaways should include both curricula and a fuel cell kit that supports hands-on activities.

7.2 Lessons learned: Approach

Hand-on Activities and the Discovery Process

Today, the prevailing pedagogy of science education holds that students must discover and experience learning through hands-on activity in order to appreciate and assimilate learning. Consequently, hydrogen educators can expect teachers to use this approach in the classroom. This means that hydrogen educators must offer “hands-on” activities and a discovery experience when teaching either teachers or students. The “hands-on” training activities should, at a minimum, engage teachers in at least one method of hydrogen production. Water electrolysis via solar energy using a photovoltaic (PV) panel is preferable but water electrolysis via battery power is a practical alternative. The hydrogen should be

utilized in an energy conversion device, preferably a fuel cell, to produce electricity that can power an application. Relative to applications, a mobile vehicle is a perennial crowd pleaser.

“Talking Heads” Unwelcome

The corollary to the lesson about hands-on activities and the discovery process is the lesson that teachers do not respond well to a straight lecture format, which they refer to as “talking heads.” Demonstrations occupy a middle ground between lecture and hands-on activities. While a mix of all three approaches is optimal, the balance is critical, if not to the effectiveness of the workshop learning, at least to teacher satisfaction with the experience. This is a challenge because there is a lot of background (government policy and economics, for example) that lends itself best to the “talking heads” approach.

Classroom, Classroom, Classroom

Teachers want the workshop and the materials they use to be directly related to their classroom experience.

Beyond “discovery” to Problem Solving and Interdisciplinary Learning

The New HOPE workshop series targets science and technology teachers but the pedagogy for these groups differs in some critical aspects. As previously mentioned, the pedagogy for science education centers on discovery. In contrast, the pedagogy for technology curriculum focuses on the related area of problem solving. The New HOPE Pilot TM curricula address both disciplines and their respective pedagogies.

Organization

Organization is crucial: it is in fact difficult to underestimate the importance of organization in the workshop experience. Teachers expect master teachers and trainers to have a clear and well-organized approach to every part of any program they are delivering. Teachers also prefer to leave the training fully equipped with giveaways -- curricula and other materials (such as fuel cells and mobile devices) -- for use in the classroom.

Mobility Matters

HOPE Pilot training and curricula emphasize the automotive sector from all perspectives (science, technology and interdisciplinary). The New HOPE Pilot takes this approach because mobility, cars and driving have a tremendous appeal, especially for all young people.

7.3 Lessons learned: Supply chain logistics & learning delivery

More Organization

For supply chain logistics and learning delivery, organization also matters – a lot. In fact, it underlies all links in the supply chain and cross-cuts all operations. It is almost the case that there is “No detail too small.”

Planning and Marketing (don’t forget to add Marketing PPT)

It all begins with planning. Consider first the teacher’s calendar and the timing in the school year, as this can greatly affect participation. Don’t forget the role of weather. In some locations there may be a preferred workshop season. With planning comes marketing – to hold a teacher training event you have to reach your target audience and entice them to attend. They need to know why this training will be beneficial to them as classroom teachers.

Teacher participation in the United States typically requires the consent of school administrations. Therefore, teachers have to be motivated to undertake the administrative measures necessary to obtain approval.

In addition to a clear explanation of the subject matter and a brief description of the event agenda, potential participants need to know the logistic details: date, time, address, exact location and parking provisions, if any. They will also need driving and /or public transit directions. Free lunch is a draw so don't forget to mention hospitality if it will be offered. The marketing process continues till the training ends. It should also include an evaluation at the end of the training with a formal survey instrument to allow measurable teacher feedback.

Resources and the Need for Substitute Stipends

Since resources are an important issue in most schools and school districts, teacher substitute stipends may be necessary to provide for the cost of substitute teachers. These substitutes would replace the classroom teachers who are attending a training event during school time.

Facilities

To increase the likelihood of success, select a desirable location as defined by your target audience. Make sure the facilities meet the event needs in terms of space, setup and audio-visual capabilities. Sketches and descriptions of all set-ups, including seating arrangements, should be prepared well in advance. It is important to coordinate closely with the hosting facility. It is also important to understand the experience level of the hosts with the type of training being offered.

Registration

The registration system should be made as simple as possible from the user's (the teacher's) viewpoint. There should be clear provision for registration confirmation as well. The system should also include a method for notifying teachers of cancellation/postponement in the event of bad weather or other circumstance beyond the hydrogen educators' control. While no system is foolproof, the notification system may need some redundancy in an effort to ensure that registered participants are timely informed.

Electronic and Audio-Visual Equipment

Planning for Electronic and audio-visual equipment is crucial. But planning alone is insufficient: all equipment should be tested in advance of the event (the previous day if the workshop begins in the morning). In addition, because smooth operation of electronic and audio-visual equipment is essential to success, it is wise to plan for a techie to be on hand to troubleshoot in the event that problems arise during the training.

Materials, Curricula, Tools and Equipment

In moving workshop materials, tools, equipment and takeaway items, it is imperative to understand the supply chain. "Supply chain" refers to what must be moved where, when and how in order to make a timely appearance at the workshop. It is highly advisable to create a contingency plan that may be put into place in the event of a supply chain "issue."

Hospitality, i.e., "food"

And last, but not least, is food. American teachers are also food critics, so apart from the obvious need to nourish the group in the healthiest manner possible, be aware that

uninteresting or sub-par food may impact the training experience and the teacher feedback. It is also wise to provide for vegetarian fare and other dietary considerations (e.g., vegan) if possible.

7.4 Lessons learned: Learning styles and participation

Teachers as Independent Thinkers

The New HOPE experience is that science and technology teachers are independent thinkers who are dedicated to making a difference in their students' lives through their respective disciplines. They generally exhibit strong concern for the environment as well as curiosity and enthusiasm for learning. Frequently, they also display a fair amount of skepticism about the introduction of new technology, especially technology that purports to have a life changing impact and/or entails significant change to everyday "business as usual" in the government or business worlds. Therefore, the Hydrogen educator's challenge is to manage the teachers' skepticism by building on their curiosity and enthusiasm as well as their concern for the environment. Demonstrations and displays of real life technology (ride and drives, fuel cell installations) can play a very important role in allaying teachers' reservations about the viability of technology.

Teacher Formation

The teachers' formation, i.e., the discipline(s) they studied and teach, affects their participation in the training because formation relates directly to their knowledge base and skill set. This is particularly apparent in "hands-on" activities that require the use of tools and equipment.

Level of Instruction

Participation also varies by the level of instruction, i.e., middle school vs. high school. High school teachers need a more in-depth understanding of hydrogen and fuel cell technology than middle school teachers. However, even at the middle school level, American technology teachers have an engineering "problem-solving" orientation that is not characteristic of science teachers at either level.

Impact of Gender

Our observation is that gender can also affect teacher training participation. As a group, females tend to have less experience with the (non-scientific) tools and equipment employed by our technology teachers. The females also tend to want to complete tasks (e.g., a "hands-on" project) and express more dissatisfaction than males when unable to do so, which typically occurs because of time constraints. Hydrogen educators can organize training activities to take these observations into account.

MTV Teachers

Finally, going back to the "talking heads" comments, remember that teachers often don't like to sit still anymore than their MTV generation students. So this means the educators should vary active and passive activities and be sensitive to "pace."

8 Closing

We hope you will find the American New HOPE Pilot lessons learned helpful as you train teachers in hydrogen education. As a final thought, remember to have fun – hydrogen education is building a hopeful and sustainable future that merits celebration.

References

- [1] American Association for the Advancement of Science (AAAS). *Benchmarks for Science Literacy*. Oxford University Press. 1993.
- [2] M.R.S. Enterprises. *HOPE Pilot™, Hydrogen Outreach Program for Education: an Interdisciplinary High School Science Curriculum*. Washington, D.C. USA. 2000.
- [3] M.R.S. Enterprises. *HOPE Pilot™, Hydrogen Outreach Program for Education: an Interdisciplinary Middle School Science Curriculum*. Washington, D.C. USA. 2000.
- [4] M.R.S. Enterprises, LLC. *New HOPE Pilot™: an Interdisciplinary High School Science Curriculum*. New York City: NYPA and NYSERDA, 2006.
- [5] M.R.S. Enterprises, LLC. *New HOPE Pilot™: an Interdisciplinary High School Technology Curriculum*. New York City: NYPA and NYSERDA, 2006.
- [6] National Research Council of the National Academy of Sciences. *National Science Education Standards (NSES)*. Washington, D.C.: National Academy Press. 1996.
- [7] New York State Board of Regents: Physical Setting/Chemistry Core Curriculum. New York: the University of the State of New York.
- [8] New York State Department of Education and Board of Regents. *Learning Standards and Core Curriculum – Mathematics and Science*. New York: 2005.
- [9] New York Energy \$mart Program.
<http://www.nyseda.org/programs/schools/default.asp>.
- [10] New York State Energy Research and Development Authority. *New York State Hydrogen Energy Roadmap*. Albany, New York: NYSERDA. 2005.