



DOE Hydrogen Program

# Hydrogen Technology and Energy Curriculum (HyTEC)

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**Project ID #ED6**



HyTEC





# Overview

## ■ Timeline

- Start: September 1, 2004
- End: February 28, 2012
- 65% complete (one module)

## ■ Budget

Total funding: \$3,015,955

DOE share: \$2,399,150

Contractor share \$616,805

Funding FY04: \$325,000

Funding FY05/FY06: none

Funding received FY07: \$150,000

Funding for FY08: \$150,000

## ■ Barriers addressed

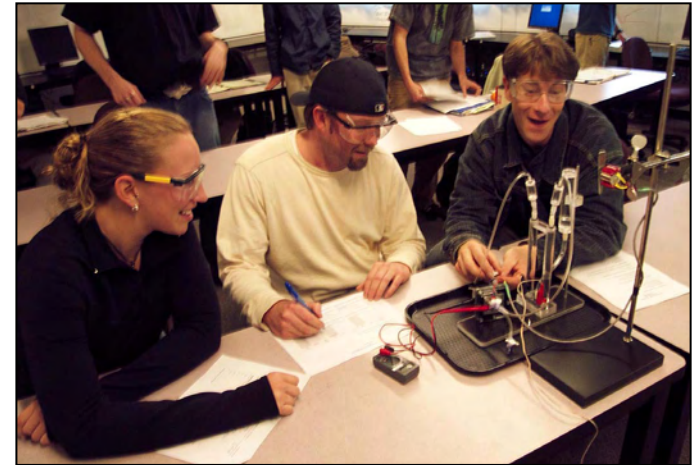
- Lack of readily available, objective, and technically accurate Information
- Disconnect between hydrogen information and dissemination networks
- Lack of educated trainers and training opportunities

## ■ Partners

- SERC, Humboldt State
- AC Transit
- Filmsight Productions
- Lab-Aids, Inc.
- Lead Institution: Lawrence Hall of Science, UC Berkeley

# Goals

- Educate high school students and their teachers about:
  - Scientific and technological basis for hydrogen and fuel cells
  - R&D currently underway to implement safe and effective hydrogen and fuel cell transportation demonstration programs
  - Current challenges and potential promise of a hydrogen economy in the broader context of energy use and resources



Equipment Testing at Humboldt State



# Overall Objectives

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- Develop, field test in national centers, revise, publish, and disseminate three curriculum modules and integrate hydrogen and fuel cells into existing LHS high school materials.
- Develop and implement a professional development plan for teachers who will use the materials.
- Develop a model for collaboration among school districts, informal science centers, university scientists, local transportation agencies, and other leaders in the field.
- Disseminate the materials to a broad national audience.
- Evaluate the quality and effectiveness of the curriculum materials and professional development strategies.



# Objectives : Phase One

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- Prepared a draft of one module that includes the most important ideas related to hydrogen and fuel cells
  - Related to National Science Education Standards and other standards
  - Able to fit into a typical high school chemistry and/or physical science course
- Partners piloted the module in classrooms
- Revised the module to prepare a version for piloting by teachers



# Objectives: Past Year

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- Revise curriculum module based on a second round of local trials
- Develop and pilot a teacher professional development workshop
- Support local teachers as they pilot materials
- Begin to develop teacher leadership for dissemination
- Develop an interactive web site to accompany curriculum



# Milestones

Month/Year	Milestones
July 2007	Milestone: Conduct first teacher professional development workshop.
October 2007	Prepare curriculum for teachers to implement independently.
May, June 2008	First group of teachers complete pilot test of curriculum materials
June/July 2008 through January 2009	Conduct second teacher professional development workshop for larger group.
September, 2008	National field test edition of print materials and kit available to schools.
June, 2009	National field test complete.



# Approach

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- Iterative cycles of curriculum development and revision based on feedback from scientists, curriculum developers, and diverse groups of teachers and students
- Teacher professional development based on curriculum activities, content background, and inquiry and issue-oriented science approaches for successful implementation
- Expansion to additional sites through LHS networks and development of teacher leadership





# Approach: The Curriculum Envisioned

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- Part of the SEPUP module series developed at UC Berkeley's Lawrence Hall of Science
    - Issue-oriented science curriculum
    - Twelve modules currently available
    - Recognized for balanced, objective treatment of issues
    - Marketed nationally by Lab-Aids, Inc.
    - Disseminated through numerous national, state, and regional workshops/presentations
    - Used with pre-service teachers in many schools of education
  - Integrated into SEPUP's 2-year high school science program (funded by NSF)
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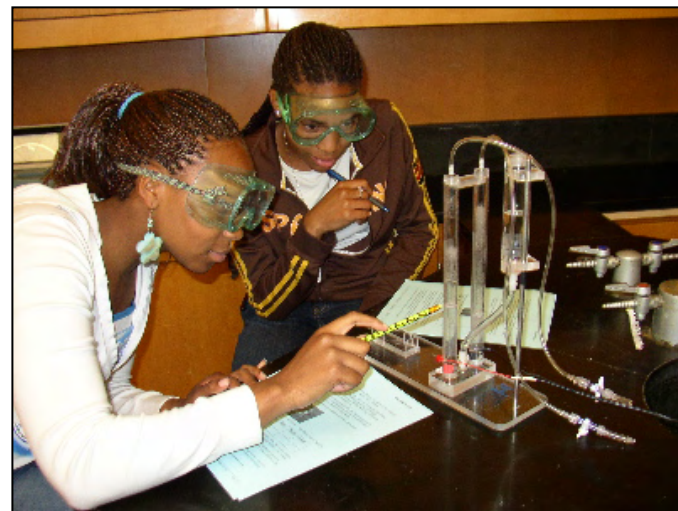
# Accomplishments: Pilot testing

- May/June, 2007: Curriculum developer co-taught curriculum in chemistry classrooms of two teachers, 150 students total, in Berkeley, CA. This led to significant revisions.
- November 2007: A teacher associate in Bellevue, CA, taught curriculum to her small AP Environmental Science class. This led to additional revisions.
- May/June 2008: Teachers who attended summer 2007 professional development teach in their classrooms.

# Accomplishments: Curriculum

Significant revision of the module flow, based on observations of students and feedback from teachers.

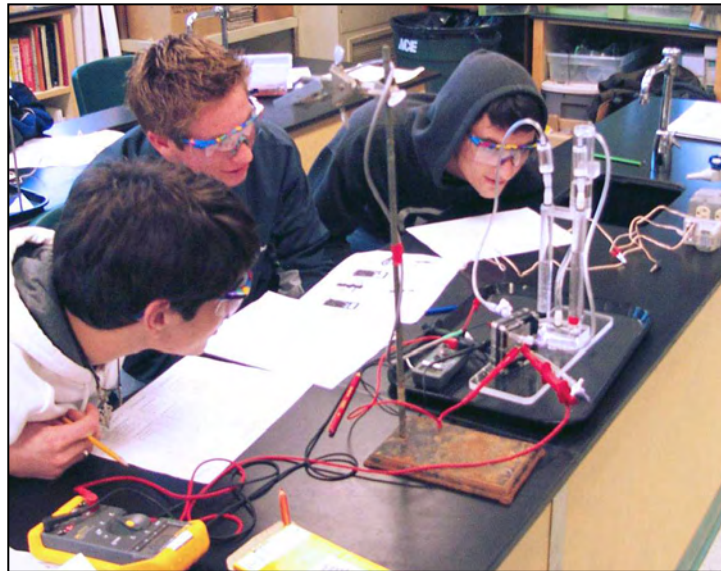
- 1. Energy for Transportation** - Students examine trade-offs of various fuel/vehicle combinations. This data analysis activity was significantly revised.
- 2. Obtaining Hydrogen through Electrolysis** - In this hands-on lab, students generate hydrogen and examine the required energy input, stoichiometry, and electrochemistry involved in the process. Original Activity 2 on fuels was deleted based on time constraints and difficulty level, but is likely to remain as an extension.



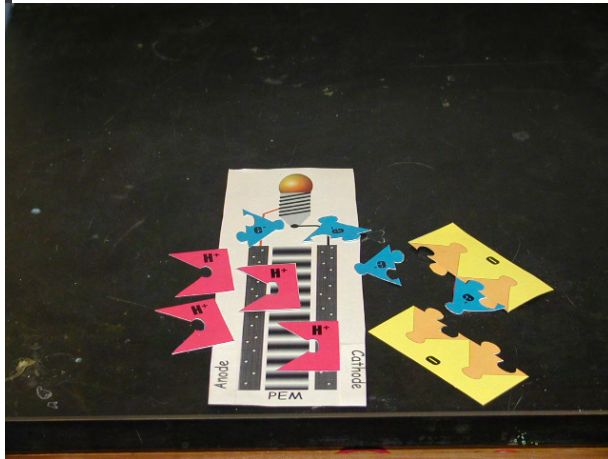
Classroom Trials

# Accomplishments: Curriculum

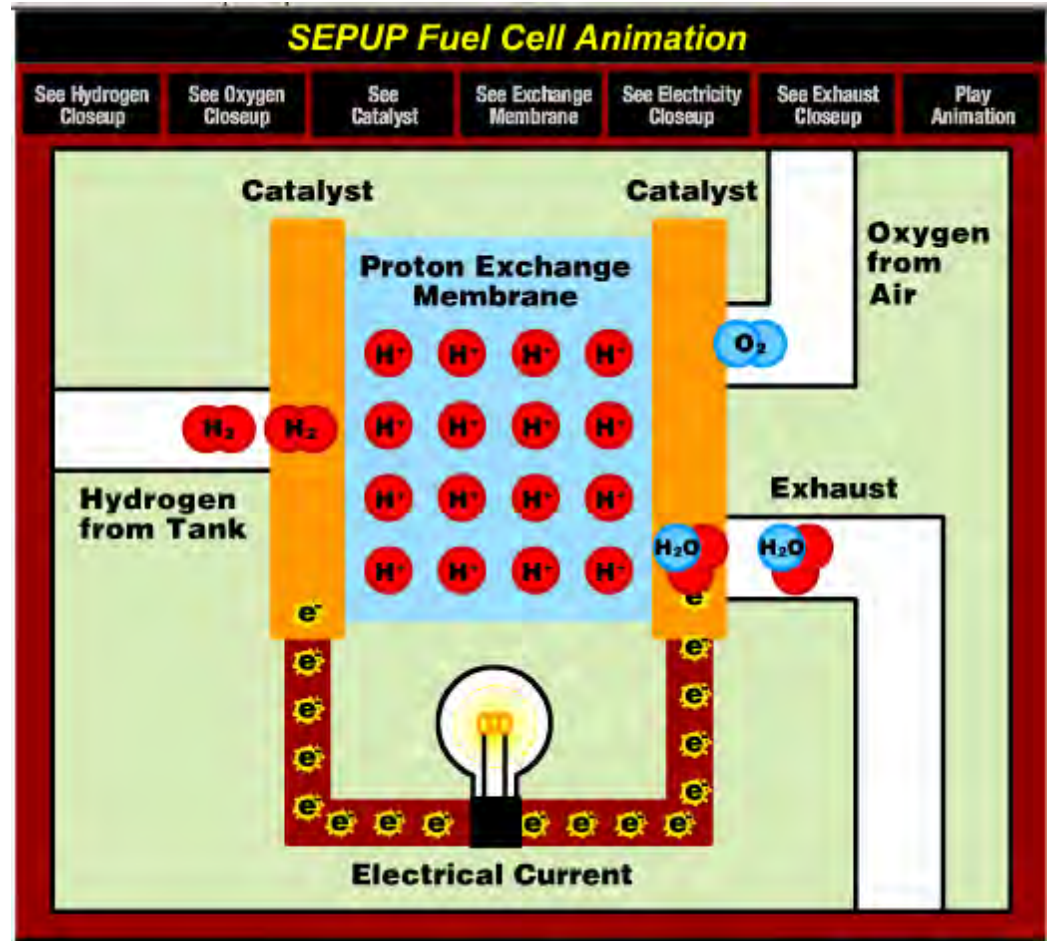
3. Putting a Hydrogen Fuel Cell to Work - Students generate  $H_2$  and  $O_2$ , and use a single cell fuel cell to perform work. Efficiency measurements were moved to Activity 5, allowing students to focus on how the materials work.



# Accomplishments: Curriculum



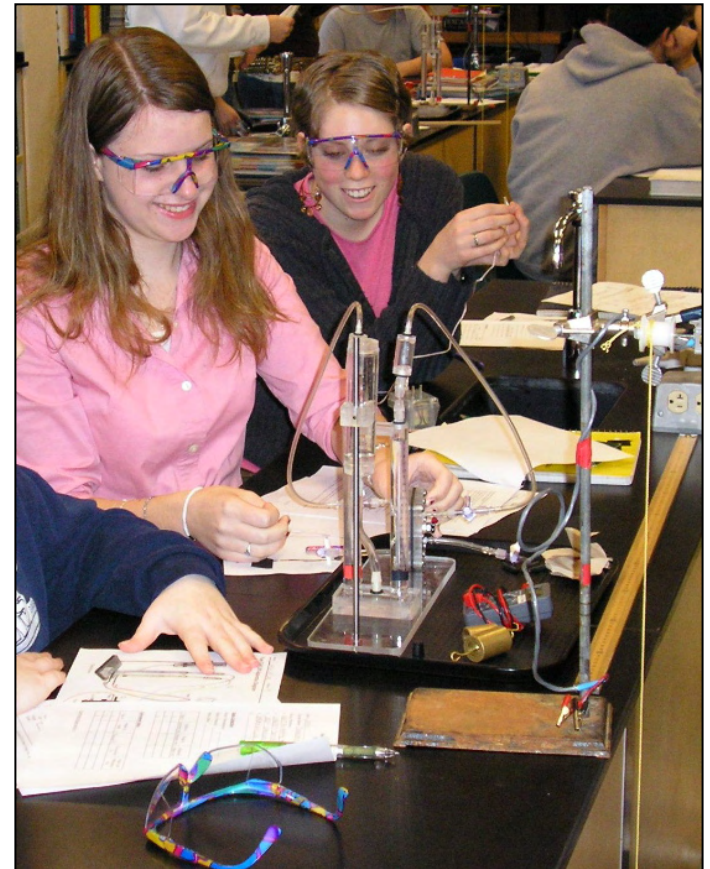
4. Modeling a Fuel Cell Redox Reaction - Students use model pieces and a fuel cell simulation to explore the fuel cell reaction. Significantly revised to incorporate the fuel cell simulation.





# Accomplishments

5. **Fuel Cell Efficiency** - In a hands-on lab, students measure fuel cell efficiency.
6. **Hydrogen for Transportation** - Students conduct research and engage in a simulated City Council Meeting to present the advantages and challenges of using hydrogen and fuel cells for a city bus program. New culminating activity/assessment.

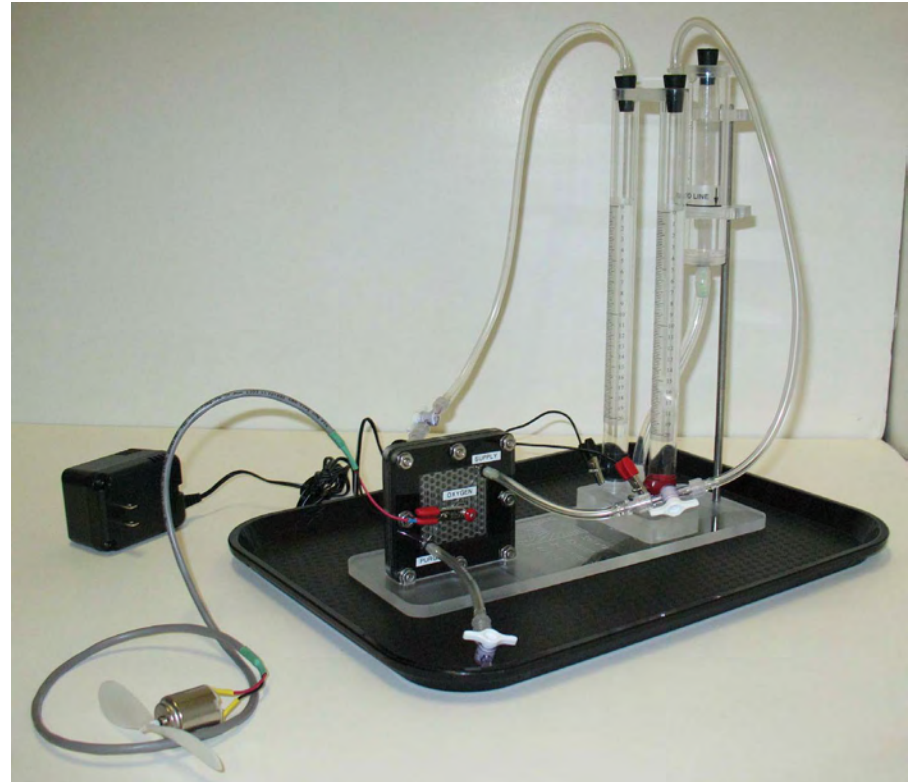


# Accomplishments: Kit

Kit materials refined by  
SERC

Publisher/kit producer  
is reviewing materials

Project partners are  
evaluating  
commercially available  
educational fuel cells

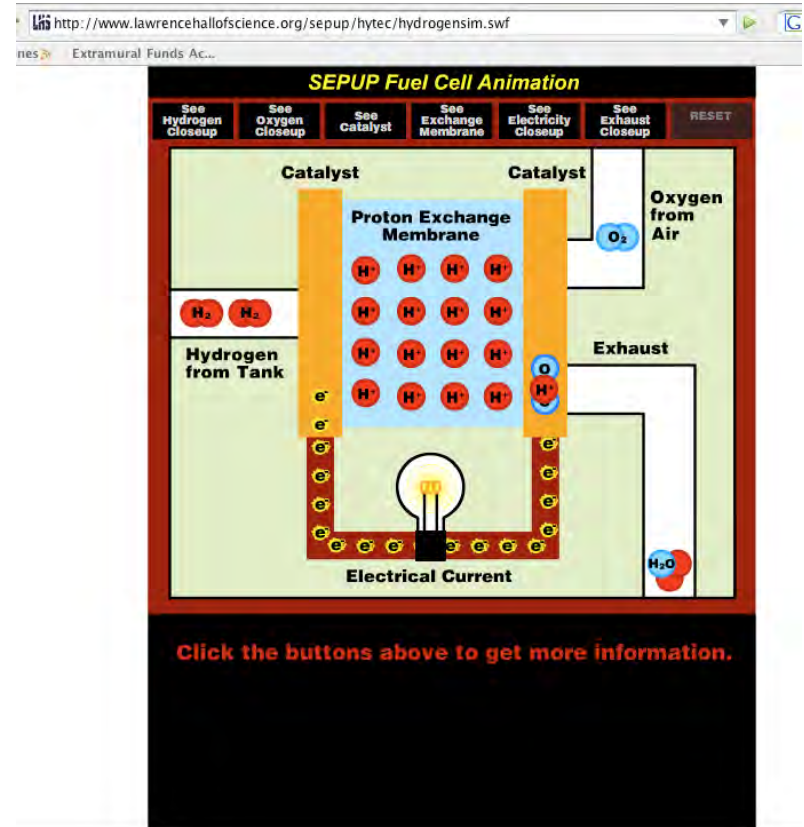


# Accomplishments: Website

HyTEC website in progress

[www.sepuplhs.org/hytec](http://www.sepuplhs.org/hytec)

- Simulations
- Clips from video field trip
- Weblinks
- FAQs





# Accomplishments: Teacher Professional Development



Two-day workshop

Participants were teachers we had worked with in pilots

Presented by curriculum developers and teacher leaders

July 30-31, 2007 in Berkeley, CA

# Accomplishments: Teacher Professional Development



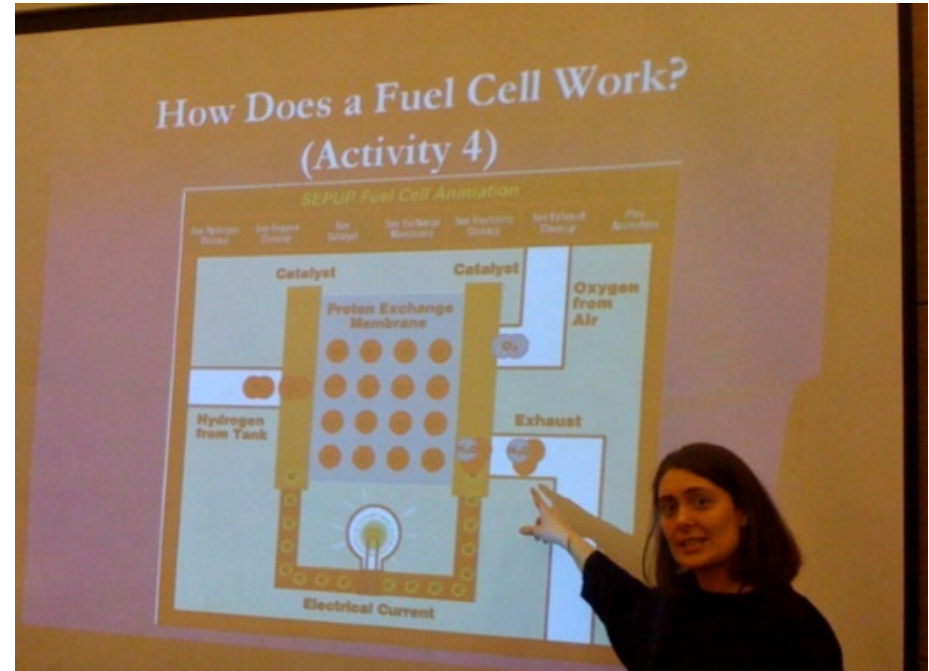
## Agenda:

- Conduct all activities
- Close collaboration with scientists/engineers
- Demonstration of a fuel cell stack
- Field trip to AC Transit bus & H<sub>2</sub> fueling station
- Feedback to developers on curriculum and professional development



# Accomplishments: NSTA Workshop

- 50 teachers received content background and an activity for their classrooms
- Bellevue, WA teacher Laura Baumgartner co-presented
- Ms. Baumgartner and a student team will represent U.S. at WHEC in Australia





# Student responses

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- Students

- Fascinated by the hands-on materials.
- Vary widely in their background on energy issues.
- Engage in thoughtful discussions about hydrogen and energy needs.
- Labs and video make it much clearer than text or simulations alone that this is real and can work.
- Applied what they learned to other situations.



# Teacher responses

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- Appropriate for either chemistry or environmental science
- Teachers are teaching the curriculum
- Berkeley teacher: This is a great end-of-the year review. It integrates concepts we have already taught through a real-world application.
- Bellevue and Emery High teachers are co-leading conference sessions
- Enthusiastic response to conference presentations and desire to become involved



# Future work

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- Three-day teacher training workshops for 15-20 teachers (June 24-26, 2008)
- Field test materials in sites outside Northern California representing diverse student groups
- Develop teacher leaders for regional and state science presentations in other areas of U.S. and increase the number of presentations
- Develop fuel cell kit into production level product that can be widely disseminated
- Finalize and prepare curriculum activities for publication

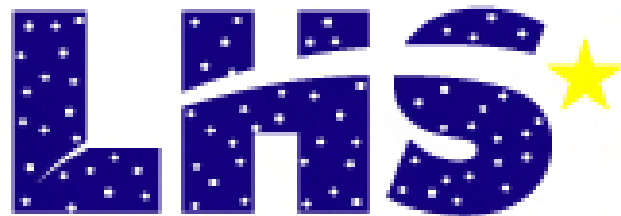


# Summary

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- Objective: To prepare for national field testing
- Relevance: To provide objective and accurate information about hydrogen in an issue-oriented context that makes sense for students and fits into the high school curriculum content
- Accomplishments: Further testing and revision of curriculum activities and kit, development and delivery of a teacher professional development workshop, teacher-led pilots of curriculum, development of a website and teacher leaders
- Future work: National field testing, publication, and dissemination

# HyTEC Collaborators



Lawrence Hall of Science  
University of California, Berkeley



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CENTER



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