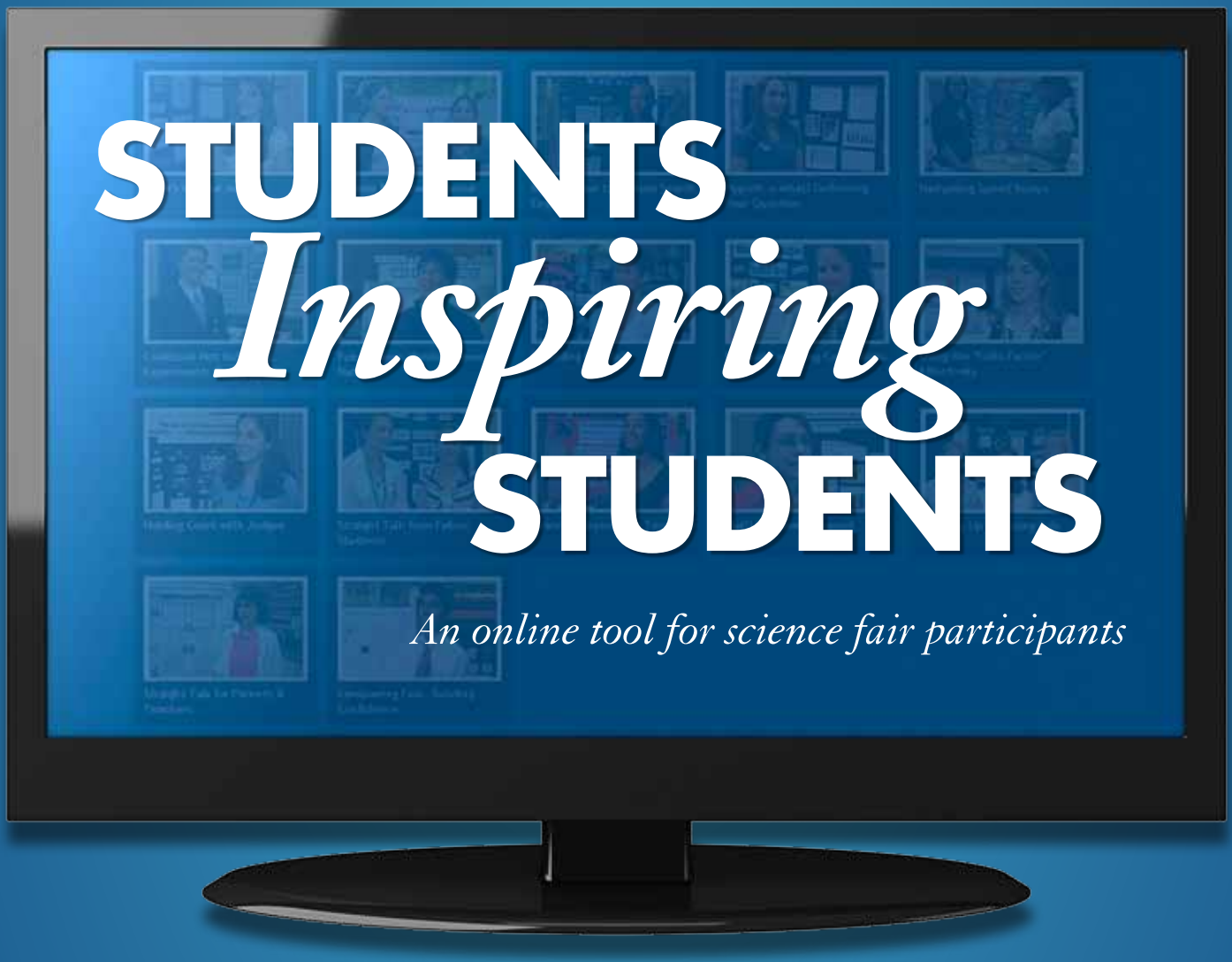

STUDENTS *Inspiring* STUDENTS

An online tool for science fair participants

Jeffrey I. Seeman and Tom Lawrence

One goal of 21st-century education is to develop mature citizens who can identify issues, solve problems, and communicate solutions. What better way for students to learn these skills than by participating in a science and engineering fair? Fair participants face the same challenges as professional scientists and engineers, even Nobel laureates. By identifying intellectually stimulating problems, solving these problems, and communicating the results to others, students learn lessons that are valuable throughout their educational and working lives (Corsi 2010).

But students who are tackling their first science fair projects inevitably have questions and anxieties. How do I choose my project? What do I do next? How do I interact with judges? The Archimedes Initiative (see "On the web") is a free, online video archive named for the ancient Greek mathematician and scientist. (Other good online science fair resources include Science Buddies and the Intel International Science and Engineering Fair's [ISEF] website [see "On the web"]. The book *Success With Science: The Winners' Guide to High School Research* [Gaglani et al. 2011] [see "References"] is another good resource.) The videos in The Archimedes Initiative were recorded at county and state science fairs and ISEF. They show students addressing their peers (Figures 1A and 1B, p. 40). This article describes the content of The Archimedes Initiative, a free internet-based self-learning experience, and suggests how students, teachers, and parents can put it to good use.

A self-directed learning experience

The Archimedes Initiative can be useful to anyone engaged in a self-directed learning experience, particularly participants in traditional science fairs such as the ISEF or online fairs, such as the Google Science Fair, launched earlier this year (see "On the web"). There are three categories of videos:

FIGURE 1A

"Straight Talk From Fellow Students."

In this theme video, students give advice to their peers regarding various topics, including how to choose their own science fair projects.

FIGURE 1B

"Revving Your Literature Search Engine."

In this theme video, students tell how they did their literature searches.

17 theme videos

Each four- to five-minute theme video (Figure 2) focuses on a single, practical subject. For example, in "Choose Your Own Science Adventure," students explain how they chose their science fair projects. Figure 3 (p. 42) provides a full listing of these minidocumentaries, which show footage of several students speaking to the theme. At the end of each theme video, Dudley Herschbach, a 1986 Nobel Prize winner in chemistry and lifelong champion of science education and science appreciation among the general public, summarizes students' comments, relating their experiences to those of professional researchers and to life in general. Theme videos 1 through 9 track the typical sequence of conducting a research project, from forming a hypothesis to reaching a conclusion. In the other eight theme videos, students offer a range of tips and advice—from how to conquer fears to the advantages of working in a team.

49 project video series

In these brief video clips, organized by project, individual students discuss their research projects, ranging in subjects from Alzheimer's disease to yeast fuel cells. Click on the "Projects" tab of the website and watch as many of the video clips about a selected project as you like. For example, click on "Cockroaches" to watch up to 14 videos in which a student scientist describes her project and discusses what she learned about herself, how she interacted with judges, and challenges she faced. These videos can inspire students to undertake their own projects and foster ideas for project subjects and methodologies.

19 topic video series

In these short videos, found under the "Topics" tab, various students discuss the same topic, such as designing experiments or using mentors. The topics roughly parallel those listed in Figure 3. A student uncertain about selecting a project may want to watch some or all of the "Choosing Your Experiment" videos, in which students who have completed their projects reveal their motivations, experiences, and insights.

Using The Archimedes Initiative

The Archimedes Initiative can improve the science fair experience for students, parents, teachers, and administrators in the following ways:

- About half of the video content provides practical how-to information for completing projects.
- Several videos can enrich the actual day of the science fair. "Holding Court With Judges," for example, can help build confidence when interacting with the judges.

- Many of the video clips, such as "Straight Talk for Parents and Teachers" and "Using the 'Folks Factor' Effectively" can help teachers and parents learn how to be more effective science fair coaches and supporters.
- Directors of science and engineering fairs can show the theme video "What's in It for Me?" to high school assemblies to encourage science fair participation.
- Science and engineering fair administrators may use the videos to help with fund-raising events. Potential donors can hear about the value of science fairs straight from students' mouths.

FIGURE 2

The "Theme Videos" tab of The Archimedes Initiative.

In the classroom

As recently discussed by Greenhow and colleagues (2009) and in subsequent commentary in that issue of the *Educational Researcher* (see "References"), there are important and novel pedagogical uses of the web for learning and teaching. Teachers can use The Archimedes Initiative website to create lessons, support an existing lesson plan, and add excitement to a class. The following scenarios suggest various approaches.

Scenario 1: Simply direct students to explore the website on their own. We observed a number of rising freshmen visit the site for the first time. They watched the videos in a seemingly random way, one after another, for over 15 minutes without pause and with full attention.

Scenario 2: Instruct students to focus on one of the various theme subjects (Figure 3). For example, assign students who are beginning a science fair project to watch the theme videos "What's in It for Me?" and "Choose Your Own Science Adventure." Follow up with classroom discussion and activities. Ask students to think about their own interests and concerns when beginning a science fair project. Place students in pairs, then assign them to explore The Archimedes Initiative's website to find potential answers by "consulting" with the videotaped students. Follow up with a whole-class discussion. To learn more about engaging students in talk strategies, see the Shea and Shanahan (2011) article in this month's *Science and Children*.

Scenario 3: Have students complete the scenario 2 assignment at home and follow up with a discussion and activities the next day in class.

Scenario 4: In a more teacher-directed approach, show the theme video that matches the stage students have reached in their own projects. Though theme videos 1 through 9 follow the logical sequence for a science project, several may be shown outside of this order. For example, "Straight Talk From Fellow Students" includes advice for choosing one's project and could be viewed following "Choose Your Own Science Adventure."

Scenario 5: The Archimedes Initiative isn't just for science fair participants; use the theme videos to support virtually any science curriculum. Because science fair projects are modeled after the actual scientific process, students can witness how "scientists" do their work. The Archimedes Initiative is an explorable resource that augments classroom discussion and independent research.

Conclusion

The Archimedes Initiative departs from the educational model of an adult standing at a lectern thrusting information at students. Instead, the site uses videos of high school students to present information, insight, inspiration, and personal experiences, including discussions of 49 actual science fair projects. Viewers are naturally drawn to videos of their peers, and as they navigate this trove of knowledge, viewers become their own teach-

FIGURE 3

The 17 theme videos in The Archimedes Initiative.

	Theme video title	Theme
1	"What's in It for Me?"	Students give reasons to participate in a science and engineering fair.
2	"Choose Your Own Science Adventure"	Students share the personal reasons each chose their project.
3	"Revving Your Literature Search Engine"	Students explain how they conducted literature searches for their projects.
4	"Hypoth-o-what? Defining Your Question"	Students explain what a hypothesis is and describe their own hypotheses.
5	"Cookbook Not Included. Experiments From Scratch"	Students share how they designed their own experiments.
6	"Fun License: Hunting Down Data"	Students explain how they collected their data.
7	"Decoding the Data"	Data analysis can be complicated, especially when using statistics. Students describe their experiences.
8	"Eureka! Cornering Conclusions"	Students articulate how they went from data gathering to reaching conclusions, a most exciting part of any science project.
9	"Holding Court With Judges"	Students explain what it was like to interact with science fair judges.
10	"Straight Talk From Fellow Students"	Students give advice to other students.
11	"Learning Beyond the Textbook"	Students share what they learned about science while doing their projects.
12	"(Self-) Discovery Channel"	Students share what they learned about themselves while doing their projects.
13	"Straight Talk for Parents and Teachers"	Students give advice to parents and teachers.
14	"Conquering Fear, Building Confidence"	Students answer the questions: "Were you ever afraid when doing your project? What did you do about that?"
15	"Navigating Speed Bumps"	Students describe how they solved problems with their projects.
16	"Using the 'Folks Factor' Effectively"	Students describe how their parents helped them with their projects.
17	"Teaming Up vs. Going Solo"	What's it like working in teams? Students discuss their team experiences.

ers—selecting videos of interest to them and watching at their own paces and under their own control. This is the essence of self-learning and self-discovery. The Archimedes Initiative is a free, unique tool to support and encourage science literacy in general and science fair participation in particular. ■

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Rewards beyond the ribbons.

Reflections on student science fair experiences.

Producing and directing The Archimedes Initiative led one of the authors (Jeffrey I. Seeman) to a number of observations and conclusions about science and engineering fairs:

- All fair participants are "stretched" academically and personally. They begin a project—typically of their own choosing—neither knowing the answer to their research hypothesis nor how to find it. They must figure it out on their own. Some students brilliantly explore enormously complex hypotheses. Others examine less ambitious problems.
- When asked to advise other students on choosing a project, students time and again say: "Choose one that interests you."
- Students recognize that their own curiosity and interests can lead to compelling research questions and substantive scientific hypotheses.
- Many students believe their research can and will have meaningful consequences for our society and that they personally will benefit from their research.
- When doing a science fair project, students are not simply exposed to the scientific process, they live it—just as professional scientists do.
- Many students find themselves both welcome and encouraged to interact with professional scientists and even work in their laboratories.
- Fair participants are experts on their chosen topics. They become more knowledgeable about their subjects than their parents, their teachers, and even the fair judges.
- Students find it exhilarating to explain their research to adults. The students participate—perhaps for the first time—in adult-to-adult communication.
- Most students gain insights about their personalities and passions.
- Students realize they can solve hard problems. They are, if only temporarily, transformed into real scientists and engineers. Their self-esteem soars.
- Students successfully confront their fears—finding, for example, they can interact smoothly and successfully with judges.
- Students learn how to be resourceful. They identify what they need to know, even when information is confusing or (initially, at least) unappetizing, such as statistics.
- Students working in teams must adjust to the various personality characteristics of their team members, just as in adult life.
- Students see themselves as adults, not as kids. They are serious in their tasks, thoughtful about their research, and serious in how they present themselves.
- Most students enjoy their time in the spotlight. Others are relieved when it's all over. Either way, nearly all value the experience.

I end with one special observation. When asked, "What did you do when problems arose?" one student echoed the words of many of his peers: "Never give up! Never give up!" We all can use encouragement like this.

—Jeffrey I. Seeman

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On the web

The Archimedes Initiative: *www.archimedesinitiative.org*
Google Science Fair: *www.google.com/events/sciencefair*
Intel International Science and Engineering Fair: *www.societyforscience.org/isef*
Science Buddies: *www.sciencebuddies.org*
Success With Science: *www.successwithscience.org*

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