Whether students are competing in science fairs at the high school, local, district, regional, state, or international level, their success is dependent on the judges’ interpretation of their work. In this article, we present a series of questions and answers from past judges—including their recommendations for success. These insights can help inform both science research programs and student performance at all levels of science fair competition. (They can also support inquiry-based learning in the science classroom, if science fairs aren’t feasible.)

The world’s largest science fair

For three years, we served as program evaluators for the Intel International Science and Engineering Fair (ISEF; see “On the web”)—the world’s largest science fair. In the opening rounds, several million students from 65 countries, regions, and territories compete for over $4 million in prizes and scholarships. From there, 65,000 move on to compete at over 500 regional ISEF-affiliated fairs around the world, and 2,000 finalists go on to compete in the final round. (Note: Information on how to create an affiliated fair and find the closest regional fair is available online [see “On the web”].)

The judge’s perspective

We wanted to capture the ISEF judges’ perceptions of the projects they judged and their suggestions for producing quality science fair projects, so we compiled data from three sources: questionnaires, a focus group, and interviews with ISEF judges. The questionnaire contained both four-point Likert scale–type items and open-ended items. The focus group and interviews were conducted during the 2005 ISEF.

Of the 1,164 judges at the ISEF, 715 (about 61%) participated in our project. On the questionnaires, most agreed that their fellow judges were of high quality and were consistent in their selection of top projects. Ninety-five percent expressed interest in judging for the ISEF again. And more than 90% agreed that top student projects were “inquiry based” and “excellent.” Surprisingly—even in the rarified air of the ISEF—more than 85% of judges thought there was a wide variation in quality between top-tier and bottom-tier projects.

To illustrate the judges’ perspectives, we here present a fictional situation in which a high school teacher wants to help students improve their science fair performances. The teacher asks a composite judge questions about his experience with great science fair projects. We created the questions to focus on the process of conducting and presenting a science
fair project and used the data from our questionnaires, focus group, and interviews to create the judge's synthesized responses. About 75% of the judges who participated in our project indicated they viewed the items found in these responses as "important" or "very important." Below is the fictional narrative:

**What differentiates science fair projects? What makes the top ones stand out?**

The vast majority of science fair projects reflect excellent work and demonstrate students' inquiry abilities. As a judge, my job is to identify the best of the best. In differentiating the quality of projects, it is important to note the methodology (e.g., how the project was conceptualized, the problem statements and hypotheses, the procedures used to collect and analyze data), the quality of the data, and the data analysis. Both students' project boards and oral presentations help judges better understand their methodologies and data.

**Some of my students spend a lot of time preparing their project boards and oral presentations. How important are these?**

It is important for students to be thorough from start to finish. The project display should

- include lab notes, which tell the story of the project from beginning to end;
- make the process easily apparent;
- be complete, organized, clear, easy to read, and concise without a large amount of unneeded information; and
- focus on the important aspects of the project. It shouldn’t be overly complicated or fancy.

The oral presentation is even more important than the project board. Finalists have to use their communication skills to demonstrate their depth of knowledge. Many oral presentations sound canned and overcoached. Instead, students should approach the oral presentation as a conversation with the judge and not an overrehearsed narrative. Good oral presentations explain students’ ideas, things that did and didn’t work, and how they made sense of the results. Students who have rehearsed presentations but can’t talk about their projects and answer questions don’t leave a good impression.

**How can my school’s course work help students with their science fair projects?**

Most science courses can deepen students’ understanding of science, helping them conceptualize their projects and discuss their results. Inquiry-rich courses can also help them develop critical and scientific thinking, vital elements of high-quality projects.

Critical-thinking skills, such as conceptualizing, analyzing, synthesizing, and evaluating data and information, are a key part of scientific thinking and are needed to employ scientific methods. Student projects should begin with clearly defined problems in the form of questions that focus the research and produce carefully planned experiments. In their data analyses, students must think critically about what they learned and what they should investigate next. Science driven by good questions and careful procedures can produce surprising data—even an experiment that didn’t turn out as expected can inform and inspire the next question.

Scientific thinking is more than trying to find solutions: It is finding ways to apply knowledge to similar situations, not being afraid of failure, thirsting for a deep understanding of how things work, and being willing to admit that learning is

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**FIGURE 1**

Top student characteristics for success in science fairs.

<table>
<thead>
<tr>
<th>Characteristics for student success</th>
<th>Mean 4-point Likert scale rating (with standard deviation)</th>
<th>Very important</th>
<th>Very important or important</th>
</tr>
</thead>
<tbody>
<tr>
<td>Critical thinking</td>
<td>3.72 (.51)</td>
<td>73.3%</td>
<td>96.1%</td>
</tr>
<tr>
<td>Creativity</td>
<td>3.63 (.56)</td>
<td>66.6%</td>
<td>95.0%</td>
</tr>
<tr>
<td>Curiosity</td>
<td>3.63 (.58)</td>
<td>67.0%</td>
<td>94.1%</td>
</tr>
<tr>
<td>Perseverance</td>
<td>3.60 (.58)</td>
<td>64.1%</td>
<td>94.7%</td>
</tr>
<tr>
<td>Intelligence</td>
<td>3.29 (.61)</td>
<td>36.5%</td>
<td>92.0%</td>
</tr>
<tr>
<td>Communication skills</td>
<td>3.20 (.71)</td>
<td>35.9%</td>
<td>83.0%</td>
</tr>
<tr>
<td>In-depth knowledge</td>
<td>3.07 (.71)</td>
<td>28.0%</td>
<td>77.8%</td>
</tr>
</tbody>
</table>

(Note: Intel International Science and Engineering Fair judges ranked these characteristics using a 4-point Likert scale, in which 4 = very important; 3 = important; 2 = somewhat important; and 1 = not important.)
a continual process. The most successful science fair projects are those in which the participants demonstrate scientific and critical-thinking skills. This is what makes scientists and engineers unique.

**Sometimes students express interest in science fairs, but more often than not, I have to recruit them. What characteristics are important for student success?**

The most important characteristic is the ability to think critically and scientifically. These are skills students learn in courses and from experiences conducting science investigations and projects. They also need creativity to choose good problems and overcome obstacles in seeking the answers. Those who are curious about the world can more easily develop a passion and desire to start and finish projects. Perseverance is also an important trait—students complete their projects over several weeks or months.

Of course, many of these characteristics are related. When there is curiosity for a topic, this fuels passion and creative energy, which helps students complete their projects. I can sense this in the interview process. Projects created without passion and creativity are often mediocre. Of course, overall intelligence and a deep understanding of the project and its related science are also important. (Figure 1 [p. 45] presents a summary of the top-ranked student characteristics for success.)

**I hear about students working on their projects with scientists or university professors in labs outside of school. How does that affect project quality and your judging of projects?**

Working in an outside lab or having an outside mentor can make a difference in a project’s quality—but this doesn’t guarantee an excellent project. Students must assume ownership of their projects, understanding not only what they did but why and how they did it.

There are benefits to working in an outside lab. Students can work at a much higher level and have access to cutting-edge equipment and materials. Each year, projects get more sophisticated, and it is common to see a few projects comparable to the work of doctoral students. This is possible because students working in outside labs are often mentored by research scientists.

If the opportunity exists, encourage students to work in an outside lab or with an expert in the field. When I judge a project, I can tell whether the student had outside help, but I also try to determine how much work and time he or she has invested. Some of my fellow judges think that students who work on their own are more likely to develop enthusiasm for their projects. They find that students who work in university labs sometimes don’t generate their own research ideas and, as a result, aren’t as invested in their projects.

**About the judges.**

To become one of the 1,200 science, engineering, and industry professionals who annually serve as judges for the Intel International Science and Engineering Fair, you must have a doctorate, master’s degree, or a minimum of six years related professional experience (Society for Science & the Public 2010). Volunteer judges are recruited by the host city committee and pay their own travel and accommodation expenses.

It is important for students to understand their projects, and if they don’t, this is evident in their interviews. When students don’t understand what an apparatus they used can do or give clear descriptions of the process, I can infer that they didn’t do the work themselves.

**What advice should I give my students to help them create better projects?**

Students must be responsible for their research. They should find topics that interest them and create projects around those topics. This will help instill a sense of ownership in students’ projects. Prepackaged projects that are handed to students seem empty. When students own their projects, they nurture and cultivate them, providing more profound insights.

**Conclusion**

Science fairs like the ISEF are fantastic opportunities for students to display and celebrate their inquiry abilities and research results. Students who have critical-thinking skills, a focus on inquiry and scientific processes, imagination and curiosity, and a solid understanding of their research can be successful in science fairs. These tools help students understand the importance of their research, guide their methodologies, and inform their results.

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**On the web**

Intel International Science and Engineering Fair (ISEF): www.societyforscience.org/isef

ISEF Affiliated Fairs: www.societyforscience.org/isef/affiliatedfairs

**References**