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Science Buddies: Advancing Informal Science Education

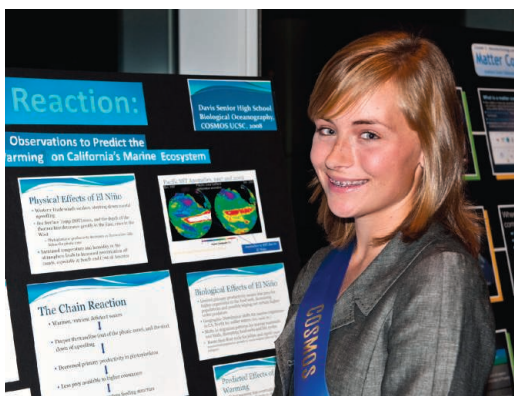
An innovative nonprofit enables scientists to present inspiring project ideas based on their own research to K–12 students, parents, and teachers.

Kenneth L. Hess,† Courtney J. Corda, Kristina M. Lanese

Every year, about 10 million North American kindergarten through high school (K–12) students complete a science project. What part of these science projects is the most difficult? Formulating a hypothesis? Designing an experiment? Analyzing data? The answer: None of the above. Science Buddies (www.sciencebuddies.org)—a nonprofit developer of software, content, and other resources for informal science and engineering education—found that students have the most difficulty selecting a topic and doing background research to inform their work. Meanwhile, scientists and engineers interested in advising and inspiring students often do not have a means to connect with them (see the first figure). To Science Buddies, these difficulties presented an ideal challenge, and we applied a business methodology to address them, viewing our users as customers and our output as products.

After analyzing customer needs, we created free products that include personalized learning tools, 15,000 pages of scientist-developed subject matter, including experiments based on the latest research, and an online community of science professionals willing to give advice to students. We also provide resources to support parents and teachers as they guide students doing hands-on science projects. Representing much more than a Web site, Science Buddies quickly and efficiently matches students with information that will hold their interest and answer their questions. The result is that, during 2010, 9.8 million unique individuals visited the Science Buddies Web site (*1*), a number equal to ~18% of U.S. students in grades K–12.

One of our programs, the Academic Outreach Partnership program provides an effective method for scientists and engineers to communicate their research to students. Through this program, a scientist can publish a "project idea" outlining how a student can conduct an experiment based on cutting-edge scientific research on the Science Buddies Web site, which shows students how science works and what scientists do every day. For example, Martin Wikelski and his team at Princeton developed "Are we there yet? Test how migratory birds navigate" (*2*). This project idea uses the team's radio telemetry data on the orientation of migratory songbirds to enable students to conduct their own version of the study (*3*). Similarly, Elizabeth Young's team at MIT developed "From water to fuel to water: The fuel cycle of the future," which allows students to explore new catalysts for splitting water, an exciting area of active research in renewable energy technology (*4*, *5*). The Science Buddies Web site is a highly effective marketplace for such outreach, aggregating across time and place large numbers of students self-identified as interested in a field and connecting them with researchers in that discipline. We welcome researchers to contact us about participating in this publishing program. On average, about 14,000 unique individuals access each project idea every year.



Science fair contestant. Science Buddies provides a bridge between scientists and students, enabling students to do projects based on current scientific research.

Our visitor demographics closely reflect the diversity of the U.S. student population; consequently, our library of project ideas must address widely varying student ages, abilities, resources, and need for instructional supports or scaffolding (*6*). A typical project idea includes a brief introduction, expected duration and cost, safety issues, prerequisites, a list of important terms, a materials and equipment list, and an experimental procedure that varies in completeness depending on the grade level of the student and the nature of the experiment. For students who need less direction, each project idea suggests a number of variations without providing the detail of a full project idea. We also have hundreds of abbreviated project ideas that provide no scaffold at all. In aggregate, students gravitate to projects with a level of difficulty consistent with their situation; they do not just pick the easy ones!

Science Buddies' staff scientists have supplemented projects submitted as part of our Academic Outreach Partnerships with a library of more than 1000 project ideas covering topics in 30 scientific fields. As part of our focus on customer needs, we monitor which areas of science receive the most interest, develop new project ideas in the areas with the most traffic, and always try to broaden the scope of scientific concepts covered. We encourage student feedback that enables us to continuously update and improve existing project ideas.

Because students have difficulty finding a topic to work on and because we strongly believe that students learn the most from a project when they have an intrinsic interest in the subject matter, we developed an "intelligent" recommender for the Science Buddies Web site (see the chart). The Topic Selection Wizard asks questions about everyday interests and grade level and then directs students to matching project ideas from our library. In 2008, the National Academy of Engineering identified the advancement of personalized learning and, specifically, recommender systems for education, as 1 of 14 grand challenges in engineering for the 21st century (*7*). The performance of our Topic Selection Wizard substantiates the value of such tools. Students who use the Wizard are 95% more likely to find a project idea that satisfies them compared with students who simply browse possible projects.

Putting a face on the numbers, one parent told us that "[his fourth-grade daughter] is into stuffed animals, loves pets, and loves the Sierra Nevada camp with its bugs, birds

Science Buddies, Post Office Box 5038, Carmel, CA 93921, USA.

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†Author for corespondence. E-mail: khess@sciencebuddies.org

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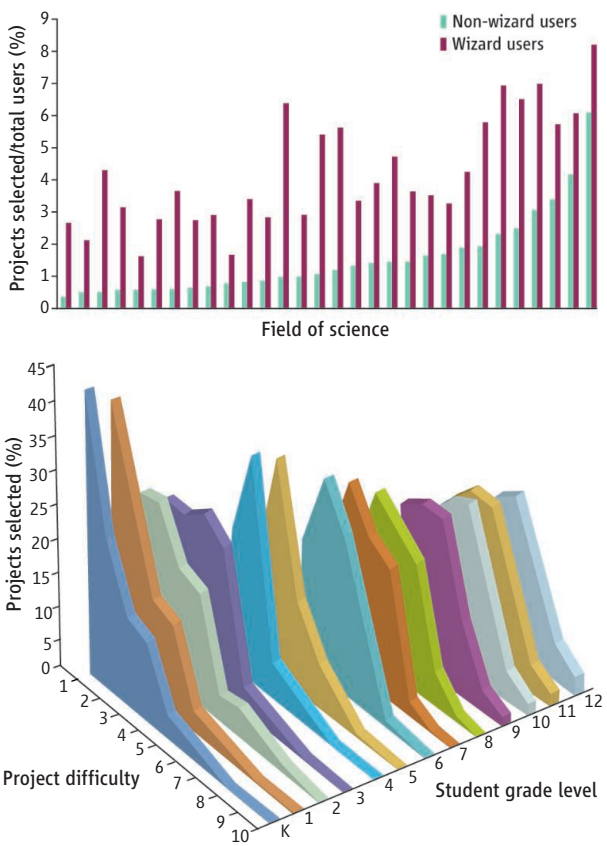
& snakes, where my wife is director. I completely expected her to do an animal project and was prepared to talk about ethics and animal-use protocols. Well, as she went through the [Wizard] questions, what we discovered is that she's deeply interested in electricity, devices, and math-oriented topics. This was a real gift to all of us." This student completed a project on static electricity, won an award at her school science fair, and reported to us, "Science is fun!"

Having a topic for a project is just the beginning. Our Web site has project guides that provide instruction on every step of the scientific method and the engineering design process. It also offers materials and guidance to develop strong researching and writing skills, which are essential to scientific practices and discourse.

For students excited about their work, project ideas link to extensive, student-friendly career profiles for related science and engineering areas. We also believe it is important for students to interact directly with scientists. Each year, science and engineering professionals volunteer their time to answer questions from students on our Ask an Expert online bulletin board. To insure a safe learning environment, all adult volunteers must pass annual background checks, and all communications with students occur in a public, moderated forum. Although most students obtain the information they need with just one or two posts, on occasion a true mentoring relationship ensues. One example is the nearly 2-year-long tutelage of high school student Christina Wang by Science Buddies Experts, especially Donna Hardy, a dedicated volunteer from Bio-Rad Laboratories. In a correspondence that comprised more than 100 posts, Miss Wang got inspiration, ideas, and practical guidance that led her from knowing virtually nothing about biotechnology to developing a screen for detecting biofilm-inhibiting metabolites in four bacteria species. Her project won a second-place Grand Award at the 2010 Intel International Science and Engineering Fair.



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Topic Selection Wizard effects. An "intelligent" recommender, the Topic Selection Wizard, helps students discover their true interests. (**Top**) Those who do not use the Wizard tend to focus on projects in fields they have heard of, so fields like "food science" are overrepresented. Wizard users are 95% more likely to find a project they like and tend to be less influenced by how well known the field is. (**Bottom**) Students naturally gravitate to projects with a difficulty appropriate to their grade level.

By providing tools that empower students and offering guides and best practices for teachers, Science Buddies makes it easy for teachers to incorporate student-led science investigations in their curriculum. Deb Bogard, a veteran middle school science teacher, says that she has "been using Science Buddies materials for 6 years, and the quality of my students' projects and learning has increased exponentially. Parents confided in me that at first, they and their children felt intimidated by the amount of work that a science project required. However, as the students began working, they found that the way the project was broken down into manageable pieces, and the instruction that was provided by the Science Buddies project guide, enabled them to take charge of their own learning. They now viewed the science project as one of the most valuable learning experiences of their school career."

The Web site is popular and widely recommended because it is free, serious, constantly maintained, and effectively marketed. We are working hard to keep it that way by developing a diverse base of funding from corporations, private foundations, and individuals.

By targeting a known need for science resources among K–12 students doing science projects and by addressing the specific problems of those customers with personalized learning tools, rich content, connections to practicing scientists, and forums for discussion, Science Buddies has built a thriving community of learning. We believe that there are many other occasions, often outside a formal educational setting, where an untrained citizen has a strong need to learn science and engineering concepts. We intend to apply a similar approach to these situations to inspire students to study science and increase the science literacy of society.

About the authors

Courtney Corda is vice president of Science Buddies. **Ken Hess** is founder and president of Science Buddies and chairman of the California State Summer School for Mathematics and Science (COSMOS) Advisory Board. **Tina Lanese** is vice president of Science Buddies.

References and Notes

1. Google Analytics, Website usage and traffic reports for www.sciencebuddies.org; www.google.com/analytics/.
2. M. Bowlin, M. Wikelski, S. Slutz, Are we there yet? Test how migratory birds navigate (2011); www.sciencebuddies.org/science-fair-projects/project_ideas/Zoo_p053.shtml.
3. K. Thorup *et al.*, *Proc. Natl. Acad. Sci. U.S.A.* **104**, 18115 (2007).
4. M. W. Kanan, D. G. Nocera, *Science* **321**, 1072 (2008).
5. E. R. Young, Y. Surendranath, T. Teets, S. Slutz, From water to fuel to water: The fuel cycle of the future (2011); www.sciencebuddies.org/science-fair-projects/project_ideas/Chem_p099.shtml.
6. Slightly more than half (55%) of the 2010 student visitors are female. Student visitors represented ethnicities of Caucasian (32%); Hispanic (12%); African-American (11%); and Alaska Native, Asian, Asian Indian, Native American, or Pacific Islander (less than 5% each), with 27% declining to state their ethnicity.
7. National Academy of Engineering, Advance personalized learning; www.engineeringchallenges.org/cms/8996/9127.aspx.

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