# Challenge-Based Learning

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*Challenges and competitions offer a compelling platform for engaging students and lifelong learners in new technologies and skill development. This special issue explores a sampling of challenge–based approaches to education and community outreach.*

Whether they are called hackathons, competitions, code-a-thons, or design projects, activities that challenge students of all ages to solve difficult problems can serve as a powerful tool for education and engagement. By tapping into our competitive and inquisitive natures, these challenges provide an incentive to advance technical and mathematical skills and enhance "soft skills," such as teamwork and effective communication. Often, competitions serve to increase diversity and inclusiveness in problem solving, inviting a broad range of viewpoints and participation. These activities can inspire young students to pursue careers in engineering and science, empower college students to apply theory to real-world problems, and help communities to address complex social problems.

In this special issue, we present a sampling of challenge-based education and innovation efforts in multiple disciplines. These articles were solicited and reviewed by the guest editors, and they represent some excellent examples of how competition and collaboration can be used to complement formal learning in the classroom. In addition, the increasing popularity of hackathons is due in part to their unique ability to help focus community groups around a collaborative approach to problem solving, rather than engaging in seemingly endless debates and discussions.

Certainly, knowledge- and learning-themed contests have existed in various forms, from traditional science fairs to mathletes and debate teams, but recent incarnations harness our broad access to technology and information, and are therefore more inclusive and attract a highly diverse group of participants. The challenges themselves are increasingly technically sophisticated, and some seek to rival athletic games as spectator events. The spirit of fun and excitement is infectious, and the sense of satisfaction that comes from achievement is palpable. By overcoming challenges, students learn and demonstrate what they are capable of, plus they can imagine themselves in careers that they never considered before.

## IN THIS ISSUE

The articles in this special issue illustrate how challenge-based education can inspire learners of all ages. *FIRST* (For Inspiration and Recognition of Science and Technology) is one of the best-known examples of this model, targeting youths aged 6 to 18 years with a focus on robotics. Competitions at various levels provide the framework for student-led learning, teamwork, and exposure to technologies across a wide spectrum of disciplines. Hundreds of thousands of creative students participate in *FIRST* events every year, assisted by a multitude of volunteer mentors.

Greenpower is an international organization that offers competitions for students aged 9 to 24 years who build and race single-seat electric cars. The younger students compete by building from a kit car, and the older students can create their own custom designs. This year, selected US teams could race their cars at the Indianapolis Motor Speedway.

For university students, Autodesk offers a set of Design for Industry challenges. Students use 3D modeling software to design mechanical devices with at least 15 unique components. Design for Space, a competition described in the article, involved the design of Cube Satellite, a small satellite that would attach to, secure, and deorbit Vanguard 1, a 1950s-era satellite. Entries from more than 70 countries were received, and experts from NASA, Mercedes, and other organizations served as judges and interacted and shared feedback with students through webinars and videos.

Members of Stanford University's Student Space Initiative (SSI) Balloons team represent another type of student-initiated challenge, involving years of effort. The ValBal team, named for their highly successful balloon design, set out to prove that inexpensive latex balloons could be used for high-altitude Earth observation and atmospheric data collection. In the past two years, the multidisciplinary team has launched 10 ValBal missions and set 3 latex-balloon endurance records. Their most recent flight logged more than 88 hours aloft, traveling more than 6,000 miles.

The final two articles highlight the power of the challenge-based approach to engage community participants in solving problems. Quantum Foundation, a private foundation in Florida, hosted a hackathon that required entrants to apply technology to solve problems important to the organization's nonprofit partners, ranging in

mission from improving healthcare to stopping hunger to reducing homelessness. The winning team designed an app called F.R.E.S.H. (Food Recovery Exchange to Stop Hunger) that connects food donors with organizations that can distribute food to those most in need.

## ABOUT THE AUTHORS

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SHP Leading Design, an architecture firm specializing in the education sector, held a Design Slam competition in which participants brainstormed spaces that would enable and enhance lifelong learning. Slam participants had to identify a unique situation or environment conducive to lifelong learning, concoct a realistic fictitious client and use case that could operate in and utilize that environment, identify the potential learning opportunities for the client and customers, and design a solution and report out to the other teams and the rest of the company. One such solution involved a place that merges early childhood education and geriatric care to enable cross-generational learning. Another idea was a working restaurant and brewery that promotes lifelong learning through such diverse skills as cooking, sustainability, scientific exploration, business practices, and gardening.

**W**e hope you enjoy reading this sampling of innovative challenge-based learning activities, and that you will be inspired to get involved as a mentor, a leader, or a participant. Computer scientists and engineers have a lot to offer to these efforts, but we also have an opportunity to learn and grow ourselves. **C**