

## From students to scientists at XLAB

Scientific principles and practices come together in a unique program for future scientists.

Eva-Maria Neher knows that experiments represent the heart of scientific inquiry. From her initial training as a biochemist to her later appointment as a visiting scientist at a local private high school, she has realized the significance of experiments for advancing new conclusions and engaging in the scientific process. So when she heard that fewer undergraduate students were enrolling in science courses, she developed a radical hypothesis: if young students were brought into a laboratory to conduct open-ended experiments that required logic and creativity, they would move beyond memorizing scientific facts and become scientists themselves. With this idea as a founding principle, the Experimental Laboratory for Young People in Göttingen—or XLAB—was formed (<http://www.xlab-goettingen.de/>). This program uniquely bridges the gap between high school and university, offering many potential scientists their first opportunity to transition away from books toward discovery in their science curriculum.

XLAB began in 2000 in laboratory space at the University of Göttingen, offering courses of only a few days—durations vary from one day to a whole week—for visiting high school classes and a small number of undergraduate students from Germany and neighboring countries. The courses, designed by experts in the field and administered by on-site scientists and technicians, delve deeply into a particular topic within the broader scope of biology, chemistry, physics or computer science. For example, a typical chemistry course might have students synthesizing organic compounds or establishing principles of fluorescence. The biologically inclined pupils might find themselves isolating bacteria, probing glucose regulation or identifying point mutations in DNA. The physicists and computer scientists would spend their time exploring energy conservation and thermodynamics, determining radioactive half-lives or developing neuronal nets and genetic algorithms.

The XLAB curriculum continues to grow as new experts get involved, and the extracurricular side has similarly blossomed: the program now runs a science festival and science-themed exhibitions and supports interactions with preschool and elementary school teachers. In 2004, the program moved into a specially designed building on the Göttingen campus as unconventional as XLAB itself: its exposed supports and unusual materials reflect and expand on the scientific principles studied in the labs.

Since 2003, XLAB has also included an international science camp, a three-week program twice each summer that brings students together from around the world to take part in intensive, expanded versions of the science courses. Neher notes that students who attend the program must be quite motivated, as “it’s not a vacation. It’s really hard work.” The group is small (on the order of 30 students), limited to four people from any particular country, and conducted in English to promote an international community. In this way, students are able to learn about other cultures, see that there are different ways to approach a problem, and, as Franziska Jennert (Germany) explains, “try to find answers to difficult questions together.”

The students have responded to XLAB’s organization and opportunities. After participating in the 2008 summer camp, Johanna Classen (Sweden) says she was thrilled with the scientific process and the complex questions the group tackled. She added, “I love working in the

lab, seeing theory in practice. XLAB certainly gives this opportunity.” Szymon Bartús (Poland) appreciated the sophistication of the program, noting that “after a few days of classes I was able to understand and perform multiplex PCR reactions. How many high schools can give students that chance?” Similarly, Lukas Hergt (Germany) jumped at the chance to get started on a scientific career, because, as he put it, “I want to have a job later where I have to think and use my brain.”

In addition to this praise for the more tangible aspects of the program, it is clear that the underlying rationale of XLAB is working: students are gaining a meaningful understanding of how scientific research proceeds in real laboratory settings. Milos Balozovic (Serbia) explains, “The most interesting thing I learned is that, in science, nothing is perfect. There are always exceptions.” HoJoon Park (Republic of Korea) summarized the summer experience by noting that “I learned that sometimes experiments can fail even if you plan them well.” Perhaps

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Bruno Götzens (Spain) puts it most succinctly, saying only, “Science requires time.” These comments demonstrate that, through this experience, students are realizing that science is neither fixed nor absolute, in contrast to the hard facts they are often taught in class, and relies on trial and error to move forward.

When Neher founded XLAB, she postulated that the experience would kindle a lifelong passion for science for some of the visiting students. Though the feedback so far is overwhelmingly positive, Neher suggests it’s too early to draw conclusions about how well the program is working, in part because many of the XLAB students—12,500 every year—are still just beginning their higher education. However, several of the first attendees have begun PhD programs around the world, and interest in the program continues to increase; indeed, by the end of February 2009, more than 75,000 students had been to Göttingen. XLAB’s commitment to an international scope is also increasingly obvious, with 15–20% of the students coming from outside Germany in each of the last three years and more than 30 different countries represented.

Looking forward, Neher envisions further collaboration, saying that she would like to establish XLAB centers in many countries “so there is a network of comparable institutions,” each specialized on a particular topic to maximize expertise and international diversity. This plan for reinvigorating science will take time, particularly because—as the science camp students can attest—the educational systems in different countries vary widely. However, getting the attention of these up-and-coming scientists on a grand scale doesn’t seem like a controversial theory. Instead, it looks like XLAB is an experiment designed for success.

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