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New Health Science Major in Minnesota Redefines Interdisciplinary

If you've ever bitten into a chili pepper, then you're probably familiar with the spicy-hot chemical capsaicin. But for professor Rajeev Muthyala, the chemical was troublesome for more than just its slow burn—it also presented a vexing pedagogical problem.

"The chemistry of capsaicin is fascinating, but it's also interesting from a physiological standpoint," the chemist says. Aside from the zesty taste—and sometimes overpowering heat—that capsaicin imparts, it can also be used as a pain reliever. A student being taught a traditional college curriculum would likely learn the chemical and physiological details about capsaicin in different classes, which might be taken years apart, Muthyala says.

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But an innovative new health sciences curriculum, spearheaded by Howard Hughes Medical Institute Professor Claudia Neuhauser, is making it easier for undergraduates at the University of Minnesota Rochester to tackle

interdisciplinary themes, including the properties of capsaicin.

The curriculum is specially designed to integrate seemingly unrelated topics, such as biology and statistics or chemistry and ethics. Neuhauser and her colleagues hope the courses will help students to make the kinds of intellectual leaps that will be crucial to their success in careers as scientists, doctors, even entrepreneurs. The first class of 55 students in this innovative curriculum, which Neuhauser and her colleagues have designed from scratch, will start in September.

“It’s not enough for students to learn a bunch of facts over four years, because the amount of information around them is exploding,” says Neuhauser, vice chancellor for academic affairs at the University of Minnesota Rochester (UMR). “We hope that through this program, students will learn to navigate that information. We want them to think critically about the world around them—and contribute to it.”

Integrating Concepts Neuhauser started thinking about interdisciplinary instruction more than a decade ago, right after she finished teaching her first calculus course to undergraduates at the University of Minnesota’s Twin Cities campus. She could tell that many biology majors in the 120 student course found it difficult to see links between science and math. The next year, Neuhauser used examples drawn from biological problems to illustrate mathematical concepts in a calculus class that was specifically designed for biology majors—and the students were hooked.

These days, Neuhauser is looking for ways to draw similar links curriculum-wide. She cites the growth of cancer cells as one example that will be used in the new health science curriculum. By studying the speed at which cancer cells multiply, students learn about exponential growth models—while also tackling difficult public policy and ethical issues associated with the disease. “We want students to use real data so that they can see that the techniques they’re learning are actually meaningful,” says Neuhauser, who in her own research studies the mathematics behind ecology and evolution. “Math can help them understand how other (scientific) phenomena work.”

To encourage this type of learning, the new courses have been organized into modules. These two or three week units focus on topics ranging from cancer to calibration. Several modules are interdisciplinary,allowing students to cover a broad range of topics in a single semester without locking into a

specific area of study. Unlike lecture-based courses that tend to focus on memorizing information for a test, the modules highlight analysis, synthesis, and interpretation. This is an idea Neuhauser has been working on since 2006 as an HHMI professor, a group of leading research scientists who receive up to $1 million to work on science education projects that ignite the scientific spark in a new generation of students.

Many of the modules include a liberal arts component. Neuhauser describes one module in which students read a section from *The History of the Peloponnesian War* by Greek historian Thucydides. The excerpt includes information about a disease that swept through the ranks of soldiers during a siege. Using evidence from Thucydides' description, current medical information, and centuries-old DNA evidence recently unearthed from a mass burial site, students will work together to build a case about what caused the outbreak.

Incoming freshman Eric Graff, 18, from Hibbing, Minnesota—one of the 55 students taking five module-based courses this fall—says he was impressed by the idea that far-ranging topics didn't require separate classes. It also won the approval of his mom, a nurse. "Having a science course linked with a math course was interesting to me," says Graff, who hopes to become a doctor. "But it also seemed like a smart thing to do."

It's not just the students and parents who are dazzled. The brand-new curriculum is drawing interest—and praise—from two high-profile organizations in the Rochester area: the Mayo Clinic and IBM. IBM's Drew Flaada, who has served as an advisor for several offerings at the Rochester campus, including the new health sciences program, believes the program's graduates will have the types of skills that IBM values in its employees. "This [curriculum] ensures that students are exposed to people who think about problems in different ways," says Flaada, director of heath care, life sciences, and emerging technologies. "We think that's a superb approach."

Tracking Progress UMR is a brand new campus, and the students in the health science curriculum are the first undergraduates ever enrolled there. Eventually, 250 freshmen will be enrolled each year.

Because they are starting from scratch, Neuhauser and her colleagues know they have a unique opportunity to measure students' progress over time. Most importantly, they want to understand how and when students learn key ideas as they move through their coursework. To do that, the faculty has created a

“concept map” that shows every topic that will be introduced in each module. That way each concept can be tested individually.

Different course modules may tackle the same idea—say, p-values, which are important in statistics—to help students understand concepts through repetition and variation. And by tracking the progress that students make on individual concepts, faculty members hope to learn which ideas pose the biggest challenges. “If a student takes a course and doesn’t do very well, it not always clear why,” Muthyala says. “Were they having trouble with a particular aspect of quantitative thinking? This tracking system can help us rectify those problems before they take the next class.”

After all, the most important concepts need to stick with students long past final exams. Students must be able to draw on them for the rest of their education—and beyond.

Challenges and Opportunities Certainly, the challenges of developing a new curriculum are myriad; while different aspects of the curriculum have been tried before, the combination of interdisciplinary classes, a health science focus, and integrated assessment is unique to the new UMR curriculum. The process requires strong leadership, faculty and administration who share similar goals, and an ability to skillfully blend innovation, idealism, and pragmatism. Still, Neuhauser says that many of these issues were eased by the simple fact that the program was starting from scratch. She helped hire the program’s five faculty members—including a sociologist, biologist, philosopher, and mathematician along with Muthyala, a chemist—based on their interest in an interdisciplinary curriculum and an untraditional way of teaching.

The program also had the advantage of facilities that were built with the unique curriculum in mind. The space for the program, which is housed on two floors just above a trendy shopping mall, was still getting finishing touches on top-notch biology and chemistry labs just weeks before students arrived. Tables in the classroom—not individual desks—encourage collaboration and discussion. And wired classrooms allow students, who are each issued a laptop when they arrive, to access the volumes of data they’ll analyze and interpret in their classes.

But most agree that the most significant part of the new program is not the technology or even the new way of teaching. Instead, the most important part of the program will be the way that students use these skills as they move into

their careers. “When students go out into the real world, they’ll be prepared to handle many disciplines, and they’ll know how they all connect to each other,” Muthyala says. “I think we give students a head start when we teach them an interdisciplinary way of thinking.”