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Benefitting the Community through Course-Based Research

BY CYNTHIA MWENJA, PhD

Paula Mazzer, professor of Biochemistry at Dakota Wesleyan University, sheds light on issues of public health through the discipline of chemistry. A deft educator, she draws her students into learning by means of hands-on research experiences. In one ongoing project, Mazzer and her students engage in meaningful local field research by working with a variety of collaborators to address the issue of algae overgrowth in a public lake near the school.

Through her work, Mazzer offers a practical example for academic researchers to have significant real-world impacts in their local communities while simultaneously guiding students to generate their own research findings to share with local stakeholders.

Chemistry for Public Health

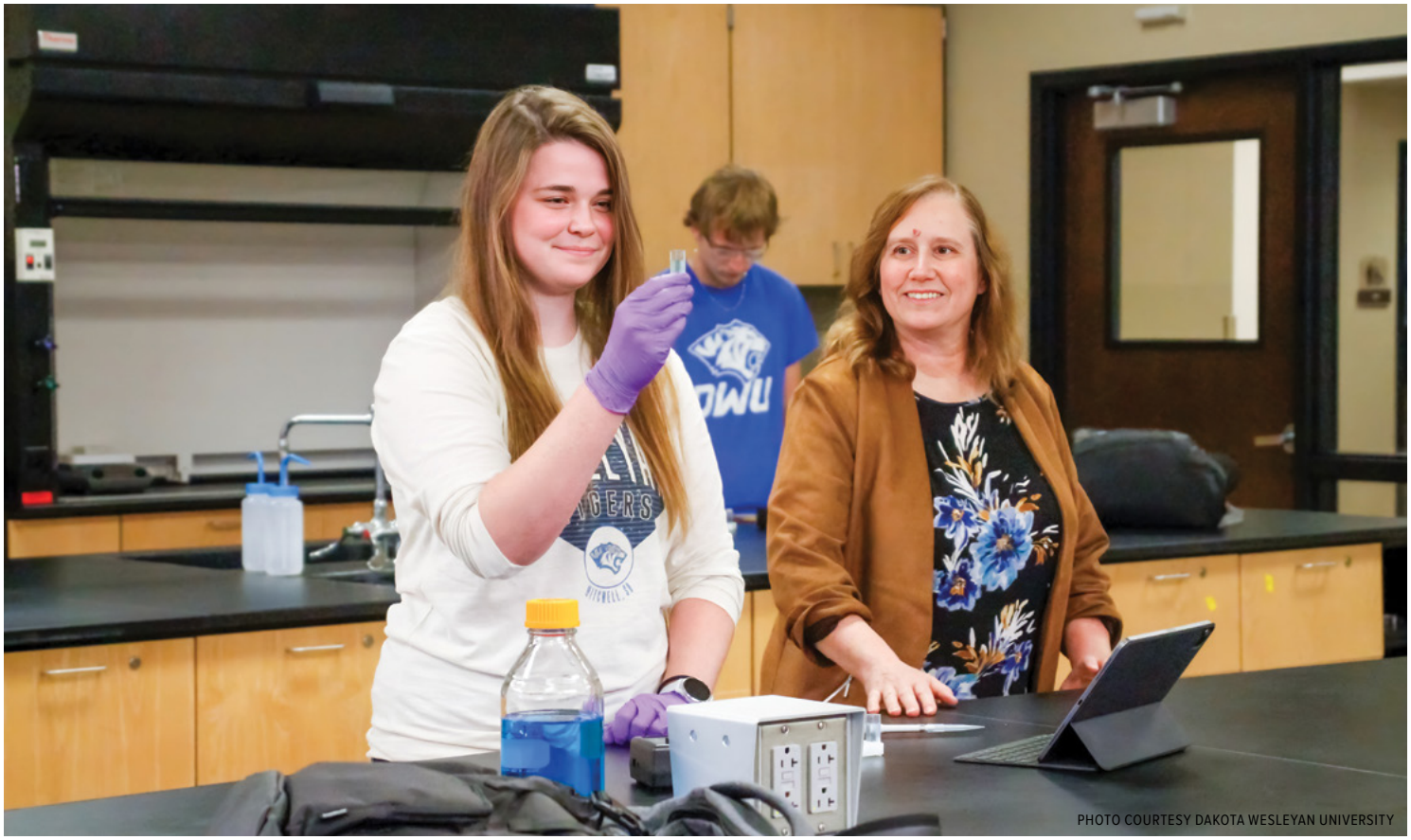
Trained as an analytical chemist, Mazzer investigates adverse effects that chemicals in the environment may have on human health. The primary focus of her personal research is how soot particulates interact with health outcomes. She says previous studies have already shown that people have a greater risk of neurodegenerative disease if they live in or near polluted urban environments. What has not been investigated, however, is which particulates relate to which illnesses. The U.S. federal government posts particulate data at AirNow.gov, but only particulate size is reported, not types of particulates. Mazzer is interested in finding out what chemicals in these particulates affect brain cells.

Mazzer often collaborates on research in this area with Patrick Hatcher, Professor in the Department of Chemistry and Biochemistry at Old Dominion University. Together, they examine how fire-derived carbon cycles through the environment. Mazzer currently works with one of Hatcher's graduate students to study the chemistry of the runoff from different types of burns. For this research, they use Daphnia, or water fleas; this sentinel organism is sensitive to environmental pollutants at much lower concentrations than fish are. Their research is showing that burn runoff does have adverse effects in the aquatic environment, but the particulates causing those adverse effects are probably removed with the first wash through a waterway. This type of research can guide local communities and policy makers as they manage cleanup efforts after wildfires.

Pedagogical Innovations

In addition to conducting research which can lead to improvements in public health, Mazzer is well known for embracing exciting approaches to learning. Several years ago, the provost organized in-house professional development workshops to fill the gap when conference travel was curtailed during the height of Covid restrictions. Mazzer was asked to spearhead the problem-based learning workshop because she had employed this and other non-traditional approaches to teaching in her classrooms throughout her time on campus.

Many of Mazzer's pedagogical innovations stem from her use of course-based undergraduate research experiences (CUREs). CUREs "offer students hands on experience doing original research and offer faculty the opportunity to generate new information within their discipline," according to the University of Colorado Boulder. Bethany Melroe Lehrman, Professor and Chair of Chemistry at Dakota Wesleyan University, notes that Mazzer is endlessly creative, pushing them both to "think and dream bigger." The two came to DWU at the same time, replacing the two previous chemistry professors. They felt an immediate bond which allowed them to take charge of the program



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and "make it their own." Melroe Lehrman states that she loves having a colleague who offers wonderful ideas for developing class projects further, and they both appreciate the freedom to innovate that DWU gives its professors.

One example of a CURE comes from Mazzer's inorganic chemistry class, where students work in groups to build solar cells throughout semester. They have a part to figure out each week, and they feel quite accomplished by the end of the term. Melroe Lehrman points out that high-achieving students can feel uncomfortable learning in these ways, but they usually realize by the end of the course that they have absorbed a great deal of theoretical and applied knowledge. Such experiences can change students' ideas of what school can be. Of course, students may appreciate this type of class even more after graduation; Melroe Lehrman knows they are likely value the "independence to discover on their own" they developed under Mazzer's tutelage when they are on the job or in the lab later on.

Taking Research Outside the Classroom

Over the past seven years, another exciting CURE in Mazzer's genetics class has developed into a project that will ultimately provide real-time water-quality data for local residents; this project will also compile data over time to guide water quality remediation efforts in the future.

Here's the background: DWU is sited in Mitchell, South Dakota, where the local Firesteel Creek was dammed in 1928 to develop "a drinking water supply and recreation center for the City of Mitchell and surrounding area," according to the city's website. The water quality has declined in recent years, mostly due to the nutrient-rich runoff from the farm and ranch land in the lake's watershed. In fact, Mazzer reports, the sediment in the lake now contains phosphorus in the same concentration as is commonly applied to crops. This buildup of phosphorus in the lake feeds harmful blue green algae blooms. Area resident Joe Kippes says that the bloom looks like turquoise paint

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spilled on the water, and its smell is "terrible." The health problems arise when the algae die off; the microcystin produced in the die-off is harmful to other aquatic life as well as to mammals. Mazzer notes that warnings are issued when the microcystin level reaches more than eight parts per billion; people then can't use the lake for any reason, and they must keep their pets away from it, as well. The die-off in Lake Mitchell was so concentrated at one point that the microcystin level in Lake Mitchell reached thirty-five parts per billion.

Kippes remembers the lake being the "center of summer activity" for generations of area residents until the algae took over. Because these water quality issues were severely affecting enjoyment of the lake, he says, some residents formed the non-profit Friends of the Firesteel (FotF) to find solutions for cleaning the water. Kippes, who is a FotF board member as well as past President, states that all members of the original board were interested citizens who were "willing to do the work." None of the board members, however, had expertise in reading and interpreting technical documents. The group asked DWU for help, and Mazzer agreed to lend a hand with interpreting the technical information the group had gathered. Kippes says Mazzer's participation in the project made them realize that they needed her expertise; she graciously accepted their invitation to the FotF board in 2020.

Mazzer also got her genetics class involved, along with individual student researchers. The students take samples at several locations around Lake Mitchell, then filter out the algae. They extract the DNA from the filter and use data analytics tools to amplify it in order to find a "bar code" of all species in the sample. Mazzer points out that this process teaches the students how to do advanced computer processing while conducting real research and investigating a subject of vital local interest.

The FotF board developed a two-pronged plan to improve Lake Mitchell's water quality: beefing up the upstream wetlands so that less phosphorus gets to the lake from the watershed, and dredging the lake to remove the phosphorus that has accumulated over the past century. They wanted scientific feedback on the plan; Mazzer had her students conduct the evaluation. Kippes appreciates the care that the students took in their assessment; they used objective data and also showed academic integrity by pointing to the limitations of their study. In their final assessment, the students said that the FotF plan would improve lake conditions, thereby giving credibility to the approach that the board had developed. After presenting their findings to the FotF board, the students also gave a presentation to the Mitchell City Council. These experiences not only train students in conducting rigorous research; the process also offers practice in communicating their findings to people outside of their field.

Mazzer and her students are further developing research at Lake Mitchell, working with a variety of collaborators. A bioinformatics professor at the University of South Dakota provides the needed computer expertise, while a professor in the Black Hills State Genomics Sequencing Facility provides the genomics information. The ultimate goal is to regularly take samples and record data at various parts of the lake, then extract the DNA and get the genomic information. This data will be automatically sent for data processing; the resulting information will be publicly displayed in a cloud-based dashboard on the Mitchell city website, with a red dot wherever hot spots of harmful algae overgrowth are occurring. This data collection and communication benefits area residents, and the project will also start building a database showing what combination of physical parameters predates blooms of harmful algae—information which may help prevent algae blooms in the future.

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Kippes notes that this project benefits all involved—the students get to apply their academic knowledge in real-world settings, and the FotF and the city of Mitchell both benefit from the data the students collect, compile, and communicate. Cities and counties across the U.S. are facing the same scenario, and Kippes would recommend that other academic researchers get involved with similar mitigation efforts—he says that working together in these ways is good on "all sides."

Academic researchers often struggle to make their coursework relevant to their students and to find ways of using their expertise meaningfully in their local communities. By contrast, Paula Mazzer demonstrates that quality course-based research can grow into projects with significant local impact, contributing to measurable improvements in local human and environmental health. The research that Mazzer organizes at Lake Mitchell provides a template to guide others who would like to involve their students in exciting collaborative projects which provide an array of unique learning opportunities. In Mazzer's research-based classes, the outcomes go far beyond standard learning objectives; they emerge from the classroom to positively impact the world.

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