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Learning Research the Hands-on Way

Research is something you can't grasp by just reading about it. You have to experience it.

This is the philosophy that drives the JFAP* Summer Educational Outreach Research Program for Undergraduates at Louisiana Tech University's Institute for Micromanufacturing (IfM), says Dr. Pedro Derosa, who adds: "It is also our responsibility towards the students."

The program recruits minorities from Grambling State University (GSU) and Louisiana Tech (LA Tech) who are integrated into a functioning faculty research group led by either Dr. Derosa or Dr. Tabbetha Dobbins. Both hold Joint Faculty Appointments at IfM and the GSU and LA Tech Physics Departments. Dr. Dobbins' research is on IfM's hydrogen storage program; Dr. Derosa focuses on computational nanotechnology.

"Our student interns have the option of participating from four to eight weeks. Those who stay in for the entire eight weeks can opt to work from a minimum of four to eight hours a day. We try to be flexible, as some students may have other activities during the summer," notes Dr. Derosa. During this period, they work in the same environment with graduate students.

Summer Research participants in 2005 included, left to right, Antwan Lawrence, Dr. Kody Varahramyan; front center, Juvet Che; Anthony Rugege, Dr. Pedro Derosa, and Dr. Tabbetha Dobbins.

"The exposure of these students to what is a valuable learning experience will serve them well in their academic and professional pursuits," points out IfM Director Dr. Kody Varahramyan. In 2005, he and Drs. Derosa and Dobbins introduced the summer

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Nanoscale Workshop Visits High Schools

It's not as if Dr. Tabbetha Dobbins had time on her hands. She holds a joint faculty position* at Louisiana Tech University's Institute for Micromanufacturing and the physics departments of Louisiana Tech and Grambling State University. She is also an active nanotechnology researcher.

But because she wants to expand the career options and opportunities of high school students, she designed and in 2006 introduced a Nanoscale Measurement and Analysis Workshop.

"My focus is on materials science and engineering, the field that actually drives nanotechnology," says Dr. Dobbins. "A combination of physics, chemistry and engineering, it is a field in which you design new materials and products utilized by everyone."

Each workshop is conducted at a high school where junior and senior level students enrolled in chemistry or physical science classes are introduced to nanoscience and nanotechnology through hands-on laboratory modules.

"I am accompanied by three undergraduates or one graduate and two undergraduate students who have undergone training on how to run the demonstrations and help the students form a hypothesis based on the information they are provided and what they want to prove," notes Dr. Dobbins.

Following a short discussion in which she explains what nanoscale research includes and why it's important, students are given two vials containing powder, one in nano-particle form, the other in standard micro-particle form.

"I ask them to examine and shake the vials and tell me the difference between the two. The point is that they can't see a difference, which brings home the message that you need advanced analysis tools in order to work in the nanoscale."

She also demonstrates a key feature in working at the nano level: nanoscale has more surface area than the norm, a factor that can change reactions that occur on the surface.

"After I give them the formula for calculating surface-area-to-volume ratio, the students measure the dimensions of a large and small styrofoam ball and I start asking questions. For instance: 'How many of the small and large balls should fit inside two identical bins?' They count the balls in each bin and, employing the formula, calculate and discover for themselves that there is more surface area on the small balls."

The students, who usually number from 15 to 20, then break into four groups to conduct one of four research explorations. One is on layer-by-layer nanoassembly, a second on creating electrostatic stabilization. The other two involve expensive laboratory instruments that Dr. Dobbins brings with her.

Through Ultraviolet Visible Spectra Photometry, which measures and identifies chemicals based on their absorption of ultraviolet

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**The Joint Faculty Appointments Program (JFAP) was introduced and funded by the National Science Foundation's Louisiana EPSCoR program and the Board of Regents Support Fund from 1998–2005. Its objective was to develop nationally competitive science and research teams through partnerships between historically black and majority white colleges and universities through joint dual-faculty hires in the science and engineering fields. The eight participating universities had a total of nine teams comprised of two to three faculty researchers each.*

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research program which was funded with a three-year grant from the Board of Regents Support Fund and the National Science Foundation's LA EPSCoR.

"In each of the first two years we recruited four students with majors in biology, chemistry or computer science," says Dr. Derosa. "Our 2007 funding was increased, enabling us to invite seven students from a list of 15 applicants, each of whom will be provided a stipend and housing.

Emphasizing that the research conducted by the students is both real and helpful, Dr. Derosa cites the accomplishments of two former interns who worked on his research team:

"One was majoring in computer science, the other in mathematics. Working together, with their expertise complementing one another, they analyzed a code that they did not write, using a technique with which they were unfamiliar, and made it work on a platform for which it was not designed," he says. "They also submitted suggestions on how to optimize its implementation that will undoubtedly make it run much faster."

An intern with Dr. Dobbins presented her findings at a national materials science conference and two others coauthored a conference presentation and proceeding paper for a national meeting of the American Institute of Chemical Engineers.

"Of the eight students who attended the first two years, four opted to continue working on their respective research teams throughout the following academic year," notes Dr. Derosa. "Of the two who graduated, one is attending University of Kentucky graduate school. Two others plan to pursue graduate studies at Louisiana Tech.

"I am especially excited that our 2007 interns will have access to LONI (Louisiana Optical Network Initiative), the fiber-optics research network that interconnects mainframe computers at Louisiana's major research universities and medical schools," exclaims Dr. Derosa. "When I joined Louisiana Tech in 2003, LONI was just a dream in progress. Its accessibility will considerably impact the student interns' research, the experience itself, and their resumes when they graduate."

Louisiana Tech's IfM Celebrates Anniversary

The 15th anniversary of Louisiana Tech's Institute for Micromanufacturing (IfM), launched in 1991 with a $10 million Department of Energy grant, was celebrated in November.

In 1995, IfM was awarded a three-year $1,165,685 grant by the National Science Foundation's Louisiana EPSCoR program and Board of Regents Support Fund for a Center for Training, Applications and Sustainable Economic Development in Miniaturization Technologies. A year later IfM's research and development building was completed and occupied.

IfM facilities are now valued at over $50 million in research and development resources. Its total grants and contracts exceed $30 million, six start-up companies based on IfM technologies have been established, and it was ranked third in the nation by *Small Times* magazine for micro- and nanotechnology education. IfM enabled Louisiana Tech to offer the nation's first B.S. degree in nanosystems engineering.

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light, the students see the difference in the absorptions of yellow, red, and green food color based on chemicals in the dye. Each then selects one of two unknowns and, using the instrument, identifies which colors it contains.

An Optical Microscopy that plugs directly into a laptop enables students to see and capture digital images and study one way to make an image smaller. Regular classroom chalk and steel BBs are placed in a tumbling device. The chalk is removed in intervals for five different samplings to track how it gets smaller and smaller. That, says Dr. Dobbins, simulates the same sort of technique done at the research laboratory scale to synthesize ceramic nanomaterials at low cost.

Following their group explorations, the students report their findings to each other by making large posters using colorful sharpie markers. About two weeks later several classes tour IfM, where research and development efforts have resulted in micro- and nanosystems for biomedical, biological, environmental, chemical, information technology, and other applications.

"The tour gives the students a better feel for what we do. I also have them bring in samples from their classroom that we can scan on a $200,000 scanning electronic microscope. One class brought in their pet snake's shedded skin," she recalls.

"Informal surveys of the some 50 students who participated in a workshop last year indicated that they most enjoyed the 'hands-on' demonstrations and activities," reports Dr. Dobbins.

"It is my hope that the workshop will open the minds of high school students to the exciting challenges and whole new world availed to them by science, encourage them to continue taking science courses and attend college with the intention of pursuing a career in the sciences."

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