Regional

Numbers, bubbles and the theory of mathematics

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College Talk

When most people think about mathematics, numbers are what usually come to mind. And if that thought doesn't scare them off, they may go on to consider the very practical value of arithmetic, algebra, geometry and calculus. Adam Weyhaupt, associate professor and chair of the department of mathematics and statistics at Southern Illinois University Edwardsville, thinks about math very differently. For Weyhaupt, a theoretical mathematician, math is all about the structure of objects.

"Let me give you a silly example," Weyhaupt said. "Imagine you are at a party with five people in the room, and any two people agree that they are mutually friends or enemies. How many friend or enemy combinations are possible?" Mathematical theory, he said, can help explain the relationship. To illustrate further, Weyhaupt turned the problem around. "How many people do you have to have in the room to guarantee that you will have at least three combinations of friends and enemies?" he asked. The mathematical principle and the theory that explains the number of relationships in this example, according to Weyhaupt, says a great deal about structure theory. It might also be frustrating to find out that there is no precise answer to his question.

"Sounds silly," Weyhaupt said. "How could we not know?" The answer, he said, is between 43 and 49 people, but we don't know and can't determine the precise number. "A computer science student of mine said that he could find the answer by designing a computer program," said Weyhaupt, who later determined that if the computer figured a calculation every nanosecond it would take the computer as much time to find the answer as the universe has existed. "That," he said with a smile, "is the kind of problem that mathematical theory makes manageable. Some problems can be helped with computers, but you really need theory to help make them manageable, tractable problems."

Weyhaupt grew up in Alton, Ill., where he attended Marquette Catholic High School. He went to Eastern Illinois University in Charleston with plans for becoming a high school math teacher. He said that he always had a strong interest in math, but that his interest blossomed into a passion while at Eastern, where he learned that there was much more to mathematics than what he had imagined.

"The more math I learned the more I thought, 'Man, this is really cool. I've got to do this some more,'" he said. He completed his Ph.D. at Indiana University where he discovered the world of theory – and began to contemplate the structure of objects.

SIUE photo

Dr. Adam Weyhaupt in his office.

Since joining SIUE, Weyhaupt has received a teaching recognition award and has published a number of articles and presentations on a variety of mathematical topics, including the subject of minimal surfaces. Leaning back in his chair, Weyhaupt smiled as he explained his research in mathematics and minimal surfaces.

"Imagine you have wire and you bend it into a loop and then dip it into soapy water," he said. "When you pull it out of the water, you might have a soapy film that stretches to the edges of the wire loop. That soap film should have some properties. There are no bumps on the surface. There would be no fingers of soap sticking up into the air or down below the surface." Why? He explained that minimal surfaces are the mathematical model that describes this phenomenon with soap films.

While understanding soap bubbles may not seem profound, understanding minimal surfaces is, Weyhaupt insists. The wall around a human cell, for example, is a minimal surface. Knowing the theory of how minimal surfaces work and being able to predict how far they can stretch and their strength can tell us how we can use the minimal surfaces of cells as building blocks, for example, in reconstructive surgery.

"This isn't really very hard to believe," he said. "You think of why a soap film looks the way it does. Well, it's because of surface tension and air pressure. What about our membranes in our cells? Well, they are going to have similar sorts of things. They're going to have fluid pushing on them from both sides and they are going to want to be very efficient from an evolutionary standpoint. Scientists are now thinking about these in terms of self-assembling structures. So these objects are useful from an applied standpoint, but I think about them from a very theoretical standpoint."

The challenge in teaching mathematics, Weyhaupt said, is in helping students develop good technical skills as well as good conceptual skills.

"It is important for students to be able to do both," he said. "The more advanced one becomes in math, the less clear it becomes what to do to solve a problem." Students, therefore, need to have good conceptual skills in order to understand a problem before they begin to try and solve it with their technical skills.

While Weyhaupt's explanations and illustrations seem to make mathematical theory look like a game, Weyhaupt said that he is actually terrible at games. His passion outside of mathematics is as an amateur radio operator. During the flood of 1993, Weyhaupt, while still a high school student, was involved in emergency communications helping people monitor flood levels.

"Everyone should study math," Weyhaupt declared. "I think mathematics is not what people perceive. Math can be very broad. I think one of the reasons we compel students to study so many years of math is because it's a very useful discipline. All of the sciences are grounded in mathematics. They need those kinds of tools."

He observed that math is also widely used in the fine arts, humanities and social sciences. Math, he added, helps artists depict shapes and forms, musicians compose and interpret music, humanities scholars analyze texts and social scientists discover patterns of behavior.

"So it's very useful, but it's also very interesting, I think," Weyhaupt said. "There's mathematics that's not useful – at least at the moment – that's just a fun puzzle. Lots of people like to do puzzles. Math can even help us understand soap bubbles."