Educators relearn the correct way to demonstrate the movement of molecules

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Diffusion refers to the movement of molecules, and is prevalent everywhere. In order for cells and body tissues to survive and absorb nutrients, the process of diffusion must take place.

Team Einstein discusses last-minute details before they test their diffusion experiment aboard the zero-g aircraft. Image Credit: Team Einstein

Diffusion is a fundamental scientific concept that is taught in many classrooms, and typically educators teach diffusion by dropping food coloring into a beaker of water. The demonstration illustrates diffusion by showing how the food coloring (molecules) travel in the water. For ages, educators have used this demonstration to teach the concept, but for one group of teachers, the well-known activity raised a question of whether diffusion is accurately presented in the classroom.

The Microgravity eXperience (Micro GX), a joint project between NASA's Reduced Gravity Education Flight Program and the Teaching from Space program, selects K-12 teachers from across the country to develop and propose an investigation to be tested aboard the zero-g aircraft.

"Micro GX is valuable to educators and students because it provides an authentic learning experience that requires application of STEM (science, technology, engineering and math) knowledge," said Education Specialist Dyane Fullwood.

Team Einstein, comprised of science educators part of the Albert Einstein Distinguished Educator Fellowship Program, hypothesized that dropping food coloring in water is not diffusion, but rather the concept of convection, the movement of molecules due to external factors. This summer, the team flew aboard the zero-g aircraft to further explore both concepts. The team decided to drop ink into liquid and observe the ink's behavior during the flight.

Because diffusion occurs despite external factors, the team expected the ink to present consistent behavior during and between parabolas. The team video

recorded the mixture's activity and saw the ink simply float in one place. When teachers drop food coloring in water, they are showing students *convection*, because gravity (an external factor) causes the food coloring to move.

"Observing the ink movement in microgravity was incredibly exciting," said Sarah Young, Team Einstein fellow and science specialist with the Utah State Office of Education. "As a science educator, I haven't had many opportunities to conduct team research. Gathering our data gave me a new perspective on the scientific process that I was able to translate to better science learning for my students."

Based on the findings, the team was able to create new classroom activities that better demonstrate diffusion, such as mixing food coloring in corn syrup.

"Many liquids, like water and ink, and gases are very susceptible to forming convection currents because of varying external forces such as temperature and gravity," said Remy Dou, Team Einstein fellow. "Corn syrup is really thick, which means currents are less likely to form. So when we observe the spread of the food coloring, we can be a little more certain that what we're seeing is due to diffusion and not to moving currents in the fluid (convection)."

Although, Team Einstein highlights this important concept, the best aspect of the experience was developing the investigation with students from their hometowns.

"Our team worked with middle school students from Utah, and they helped us select the best liquid to use in the experiment," Young said. "We weighed out different options, and the students selected water.

"This experience was equally shared by teachers and students. Not only were we teaching the concept of diffusion, but we were teaching students how to ask questions, investigate their surroundings and examine ideas from a different perspective."

Team Einstein's findings were recently praised by the National Association of Biology Teachers and published in American Biology Teacher, a professional educator's journal.

"The success of the Einstein team demonstrates NASA's intent to use our unique assets to support educator teaching ability," Fullwood said. "Now, teachers who read the published article will rethink concepts and adapt the team's methods of teaching diffusion."

Because NASA offers unorthodox professional development opportunities,

educators from the across the country are able to improve their craft, inspire young minds and uncover revolutionary discoveries that improve STEM curriculum and classroom instruction, ensuring students receive the best education possible.

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