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HOOKED ON STEMGENETICS

Genetics curriculum blends teacher-led discussion, online learning and hands-on activities

Fifth graders learn about genetic information by observing the inside of a seed.
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The study of genetics may not be typical in a fifth-grade classroom. But fifth-, seventh- and ninth-graders are benefiting from an innovative curriculum that combines teacher-led discussion, online learning and hands-on activities to broaden students' understanding of how genetic information moves from one generation to the next.

STEMGenetics was developed by Michelle Williams, an associate professor of science education at Michigan State University and Angela DeBarger, a senior research scientist at SRI International.

Now in the third year of a five-year National Science Foundation (NSF) grant, STEMGenetics focuses on familiarizing students with grade appropriate genetics concepts, assessing their grasp of the concepts and providing professional development for teachers involved in the program.

Williams says she and DeBarger chose genetics because "it's an important topic to society and is personally relevant to people in their everyday lives, even young children." She adds that when it comes to genetics "many students have an array of ideas that are not scientifically accurate. By starting early on, we have an opportunity to

A fifth grader shows Sen. Debbie Stabenow that the embryo of a seed contains genetic information.
Credit and Larger Version

Sen. Stabenow investigates plant genetics using digital technology with fifth graders.
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Congresswoman Eddie Bernice Johnson investigates the inside of a seed with fifth-graders.
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A student works with fifth-grade teacher Wintrill Maiden to grow her

build a more coherent understanding of the subject."

The project currently serves almost 2,000 students in nine schools in East Lansing, Mich., and Cedar Hills, Texas.

Over five weeks, each grade tackles a series of "motivating questions" such as "How do plants in the same species vary?" or "How do we breed rice plants for high nutrition?" As teachers guide students through the material, they introduce hands-on activities such as planting seeds and crossing different parent plants.

"These activities stimulate a lot of great conversation," says veteran teacher Rob Voigt. Much of the discussion grows from students making predictions and drawing conclusions about genetic information.

To support classroom concepts, students also engage in online modules that may include a story related to the topic, short videos and interactive sections in which students examine data, reflect on it and input their responses in drop-down dialog boxes. Animal and plant breeding simulations help students visualize how genetic information combines to produce various types of offspring.

"This project demonstrates the value of bringing tools of scientific research to younger students," said NSF Program Director Julia Clark. "Having the opportunity to engage in scientific thinking builds a great foundation for future study."

Collaborating on a curriculum

Developing the STEMGenetics content and supporting technology took a small village of scientists, teachers, technology developers and assessment experts. DeBarger and Williams co-designed the units with teachers from different schools and across grade levels. "We had content experts and mentor teachers look at the learning goals to decide which ones are learned best through an interactive model and which processes are appropriate to learn," says Williams. The teams then developed storyboards to convey the concepts so that programmers at SRI could build the simulations and other visuals for the units.

To package their material, Williams and DeBarger wanted a tool that would bring content to the classroom in a unique and effective way. They turned to the web-based inquiry science environment (WISE) developed at the University of California, Berkeley by Williams' former doctoral mentor Marcia Linn. Specifically designed to promote critical thinking skills, WISE has software tools to help students make and justify predictions, describe observations and develop conclusions supported with evidence.

"Students gain experience constructing a good argument and supporting it," says Williams. "A skill," she points out, "that is crucial not only in science, but across disciplines."

The reflection and writing opportunities also act as an assessment so that teachers can monitor student progress. Based on the answers

Wisconsin Fast Plant.
Credit and Larger Version

Students analyze offspring resulting from different parent combinations using a dragon simulation.
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Fifth-grade teacher Rob Voigt works with students to germinate seeds.
Credit and Larger Version

students provide, teachers can encourage the class to think more deeply about a concept or adjust a lesson if students are struggling with a concept. Teachers track lesson adjustments and supply that information to Williams and DeBarger.

"We get data back each year from the teachers and refine the units over the summer," says DeBarger.

Supporting teachers

While technology enhances classroom activities, supporting teachers as they present scientific concepts is essential to the program.

"Teaching is a profession like medicine, and teachers like doctors must be constantly learning," says Amal Ibourk, a graduate student researcher with STEMGenetics. To assist teachers, STEMGenetics offers a robust professional development program that includes a summer workshop, after-school meetings to discuss program nuances, faculty mentors and co-teaching.

"Our goal is to help teachers build scientific practices and model them to the students," says Ibourk, herself a teacher. These practices include thinking deeply about a passage or critically about data. "If you start at a young age, these practices become a skill."

Fostering lifelong science learning

One of STEMGenetics' strengths is its ability to get students to link ideas in the real world with those in science.

"We want to encourage students to continue linking ideas in life with ideas in science," says Linn. "The goal is for everybody to keep learning science." However, achieving this goal is complicated as Linn notes, because "it's fairly common for people to stop learning science."

As the project moves forward, Williams and DeBarger will focus on two key directions: downward and outward. The team wants to apply what they've learned with middle- and high-school students to students in kindergarten through fourth grade.

"So much that goes on in K-4 helps prepare them for the upper grades," Williams says. "We have a nice opportunity to go downward and enhance other areas of biology."

To raise awareness among policymakers, Williams has been meeting with both state and federal legislators, encouraging them to visit classrooms and see how students and teachers are engaging in science.

"Getting people in the classroom really changes their view about science," says Linn. Adds Williams, "I really want policymakers to see kids excited [about science] and to interact with them. It's crucial to invest in children early on, not just in high school."

Williams' enthusiasm is contagious. When U.S. Sen. Debbie Stabenow

(D-Mich.) visited Rob Voigt's fifth-grade classroom at Glencairn Elementary in East Lansing, Mich., she didn't want to leave. The students brimmed with exuberance as they engaged her in a genetics lesson. The same energetic scene played out again in Texas when Reps. Eddie Bernice Johnson (D-Texas) and Mark Veasey (D-Texas) visited West Intermediate in the Cedar Hill School District.

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Related Institutions/Organizations
SRI International
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Related Websites
WISE: The Web-based inquiry science environment:
www.wise.berkeley.edu

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