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STEM challenges and solutions in the hinterlands

By Carol Kreck

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When it comes to teaching STEM — science, technology, engineering and math — in remote rural areas, intractable problems can become brilliant solutions.

The list of rural STEM problems is the same from shore to shore: getting teachers to move there, getting them to stay, lack of teacher mentors, fewer math classes, inadequate labs and inadequate bandwidth. But across the country, solutions abound:

- Not enough bandwidth to access the Khan Academy for math and science? Go to KA Lite, Khan Academy videos and exercises that can be downloaded even when no Internet is available. That also addresses the problem of too few math classes.[1]
- Nobody to mentor new STEM teachers twisting alone in the rural wind? Try E-Mentoring for Student Success, an innovation of the New Teacher Center in Santa Cruz that assigns new teachers in far-flung areas to mentors who help them several times a week by email, phone or Skype.[2]
- Worried about teaching the Common Core in places without urban amenities? At the Walton Rural Life Center in central Kansas, kids raise farm animals, sell eggs and grow snacks — hands-on learning folded into the Core; twice in the six years of its existence, students scored in the state tests' top 5 percent.[3]

Billy Hudson, the Elliott V. Newman Professor of Medicine at Vanderbilt University, knows something about science in rural areas. Having grown up poor on Garden Seed Road in Grapevine, Ark., Hudson considered dropping out at 16 to escape his abusive home. A teacher saved him.[4]

Pondering his lifetime's mentors, Hudson returned to Grapevine in October 2005 at the age of 64. He boarded the school bus on Garden Seed Road with students ranging in age from kindergarteners to seniors in high school for the hour-and-a-half ride to school.[5]

In April 2007, he and his wife, assistant Vanderbilt vice chancellor Julie Hudson, outfitted a couple of school buses with iPods, laptops and a mobile Internet router. The school bus initiative is over, but rural districts across the country are outfitting similar buses. Now Hudson's Aspirnaut initiative has high school and undergraduate STEM summer internships and beams weekly STEM classes into schools in **Alabama, Arkansas, Maine, Mississippi, Montana, North Carolina, Tennessee** and **Virginia**.[6]

Among the most remarkable stories is out of Dedham, **Maine**, where middle-schoolers who Skyped every week with Vanderbilt scientists harvested sea anemones with a Ph.D. student from Vanderbilt and discovered sulfilimine, which may eventually aid in cell regeneration.[7]

While the Hudsons do not want to set up mentoring systems for rural teachers in every state, they do think Vanderbilt's Aspirnaut program could be a model hub for other universities and other states.

Some states — **Iowa, Ohio, Oregon, Michigan, New York, Washington** and Tennessee among them — have set up STEM hubs of their own. K-12 schools, universities, businesses and community organizations have coalesced to enrich curricula, provide professional development, connect organizations and schools, bring more college-level courses to high schools and relieve the isolation of rural schools.[8]

One Oregon businessman said an advantage of building a pipeline of STEM-educated local students was that they have strong family connections and were more likely to stay for the long term.[9]

Michigan has five hubs, Iowa six. In March 2014, the Oregon Education Investment Board, chaired by Gov. John Kitzhaber, awarded $2.8 million in grants to his state's six hubs. Maine started its STEM hub initiative in 2013 through the Reach Center at Maine Mathematics and Science Alliance. Each hub has a STEM Guide, "locally embedded experts who have an interest in STEM and are familiar with local needs and interests in their communities."[10]

Ideas for Statewide Support

Create STEM hubs. In many states these provide resources for schools and teachers allowing them to access curricula, experts and professional development.

Expand dual enrollment. More than half of all Iowa's high school seniors are joint enrollment students.

Create summer programs for rural students. STEM Scholars in Florida is a summer program bringing in rural students to work with scientists and a forum of engineers representing various industries. FloridaLearns STEM scholars program serves gifted high school students in one of three rural areas.

Create digital resources. Kentucky, first state to adopt the Core, created an electronic statewide classroom module that teachers could use to find lesson plans and pacing guides aligned to the Core.

Maximize Advanced Placement opportunities. Kentucky's AdvanceKentucky, created to increase access to AP classes, increased by 92 percent the number of AP students since 2008 and doubled the number of students who scored a 3 or better.

One theme seen in hub systems and other successful STEM initiatives is the use of location. Iowa Lakes Community College hub takes advantage of the local wind power boom and has students designing wind turbines in annual contests. Such is the case with Kansas' Walton Rural Life Center.[11]

The small town of Rootstown, Ohio, took advantage of proximity. The Northeast Ohio Medical University is there, and on its campus is located the Bio-Med Science Academy, which is "key to bringing opportunity to rural students who may be interested in pursuing careers in science and medicine."[12] The year-round public high school was granted STEM designation in 2013. One issue is the shortage of doctors in rural areas. "We want them to know it's OK to go away, but it's also OK to come back and give back," said the school's director, Stephanie Lammlein.

Reading the River, a program using the Licking River watershed in eastern **Kentucky**, was developed by two local professors to "increase the level of confidence and degree to which teachers (a) use hands-on inquiry-based teaching, (b) integrate the sciences, (c) integrate science with other areas, (d) use community-based resources (e) use the local environment, (f) teach real world current issues, (g) use technology in their teaching, (h) conduct field-based investigations and (i) teach watershed topics.[13]

In **Hawaii**, elementary students from Keaau Elementary hiked to the Kilauea volcano and broadcast their adventure to Nanakuli and Hale Kula schools via Google Glass and other devices.[14] Also with the help of technology, students from rural schools on Oahu's west coast study ancient Hawaii, using tablets to create virtual fishponds and learn about the sustainable land division concept of the Ahupua'a (mountain to the sea).[15]

Not all rural areas have access to Google Glass, let alone bandwidth. More than 70 percent of America's schools lack the Internet speeds necessary to prepare students and to test them on the Common Core.[16] "Technology is expanding access to knowledge, innovation, instruction and professional development in unprecedented ways," U.S. Secretary of Education Arne Duncan told the Rural Education Forum in October 2013. "Technology is driving both greater equity and an increased focus on excellence." [17]

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> *— Arne Duncan, U.S. Secretary of Education*

Duncan acknowledged the lack of bandwidth in some rural areas but said the federal government was making inroads. "Since 2009, USDA and the Commerce Department have provided about $7 billion in Recovery Act funds to expand or improve broadband service in 7,000 schools — with more than 3,300 additional schools slated for connection or upgrading."[18]

High-speed Internet will enable rural students to take online classes and gain access to cutting-edge research at universities. It will bring Advanced Placement classes and foreign language programs and will enable teachers to customize lessons for students at different learning levels, Duncan said.[19]

Broadband access can vary radically within states. In **Arizona**, Sedona Unified School District has 4 Mbps while Peoria Unified has 38,200. Arizona Gov. Jan Brewer vowed to address digital disparities, but to help pay for upgrades she proposed charging school districts and charter schools $15 per child for six years. An outcry ensued.[20]

Schools still trying to use dial-up should consider KA Lite, open-source software that can be downloaded and run on any computer, "turning it into a webserver for viewing and interacting with downloaded Khan Academy videos and exercises, even when no Internet is available." Though it is hard to find out how many offline communities use KA Lite, staff has confirmed it's in about 80 countries from Argentina to Zimbabwe.[21]

Idaho is in the midst of taking the Khan Academy to every school in the state; its corrections system is using KA Lite for prisoners who have no access to the Internet.

To take technology's possibilities in rural areas to the extreme, look at **Alaska**'s Lower Kuskokwim school district. One K-12 has only 18 students and is inaccessible except when the Kuskokwim river is frozen over. Still, they have access to geometry, biology, electives such as digital photography, robotics and the native Yup'ki language via videoconferencing.[22]

A teacher in Bethel, the district's base which is also inaccessible by road, can see her students in several schools; they can see her, interact with her and with each other. Assistant Superintendent Dan Walker gets credit for relentless effort to acquire a land-based system, which should costs $20 million a year. Lower Kuskokwim pays only $2.5 million with help from the federal E-rate program.[23]

Technology also may play a role in mentoring new teachers. In **California**, the Santa Cruz-based New Teacher Center has a nationwide program called e-Mentoring for Student Success (eMSS), in which teachers are matched with mentors for instructional help and professional development. Especially for rural states, small districts and hard-to-staff school areas, the mentors communicate several times a week by phone, Skype or computer. Seventy percent of mentors have received state or national recognition.[24]

Several towns in rural **Georgia** formed a public telecom utility, then hired Beau Sherman to help their schools realize broadband's educational potential. Now rural Southwest Georgia schools get live interactive science demonstrations via Georgia Tech whose research scientists demonstrate principles of astronomy, high-energy physics and nanotechnology.[25]

Sherman, Regional Distant Learning and Video Coordinator for Education for Community Network Services, said that, "with agriculture being the number one industry in the state, we are looking to inspire students to learn globally and live and produce locally. Agriculture and STEM education are a natural fit. With GPS-guided equipment and variable-rate irrigation and fertilizer applicators to better manage natural resources, education is key."

Models for local solutions

At **Indiana**'s Purdue University, "Stem Goes Rural" trains math and science teachers to serve a minimum of three years in a rural community.

Montana — where 75 percent of schools are in rural areas — built small museums dedicated to STEM subjects. The Big Sky Space Education museum in Helena can be distributed in three forms: the full exhibit, panels with software and software only. The size of the exhibit allows it to be set up in many locations such as a school classroom, a church basement or library reading area, allowing it to be transported to rural areas.

James Madison University in Harrisonburg, Va., established the National Center for Rural Science, Technology, Engineering, and Mathematics Education Outreach. The initial emphasis of the Center will be on helping students and teachers use geospatial technologies. Lessons and professional development are provided.

In Maine, 44 teachers and 500 K-12 students from the coastal region, including isolated islands, will develop IT and GIS skills while working with partners in Maine's fisheries. The Community for Rural Education, Stewardship, and Technology (CREST) is funded by the National Science Foundation.

Tennessee, with a statewide STEM Innovation Network including six STEM hubs, tackled a rural project in Oak Ridge. Nine rural K-12 districts partnered with business leaders to create a Lab-in-a-Box initiative in which equipment for a series of hands-on lab experiments tied to school deficiencies on state tests is delivered to schools in boxes. Tennessee's Upper Cumberland Rural STEM Initiative Hub has its own STEMmobile, a 53-foot tractor-trailer with self-contained power, its own HVAC system, a satellite uplink for Internet connectivity, and adjustable-height work stations for 24 students.

Mississippi State University partners with three rural school districts in North Central Mississippi, matching 50 research fellows in geosciences, physics and engineering with teachers. Goals of the program, Initiating New Science Partnerships in Rural Education (INSPIRE), are to enhance fellows' communication, teaching and team-building skills; develop and implement technology-supported, inquiry-based instructional materials; increase K-12 science teachers' content knowledge; build partnerships between K-12 districts and university STEM disciplines; and provide international research experiences for fellows and teachers.

State policy supports

Mobile buses
In Arkansas, H.B. 1273 (2009) created a mobile learning technology pilot for rural school districts. Each participating district will equip school buses with wireless Internet and purchase laptops, portable devices for storing video files, media screens and math and science software. Participating districts may use foundation funding.

Infrastructure
Kansas's S.B. 614 (2002) provided funding and requirements for contracts with telecommunications carriers for provision of broadband access of the KAN-ED network which will provide broadband to schools, libraries and hospitals.

Arkansas' H.B. 1682 (2007) made an appropriation to the State Science and Technology Authority for the STEM Coalition to develop a plan to improve laboratory facilities and enhanced learning environments for STEM teaching in K-12 schools.

Tennessee's S.B. 2519 (2014) required LEAs to survey students within one month of the start of the 2014-15 school year as to the availability of Internet in their homes and report results to the department of education; the department will report the results to the governor and the education committees of the house and senate.

Idaho's S.B. 1410 (2014) established criteria that districts must meet to be eligible for state funds for wireless technology infrastructure in grades 9-12.

New Mexico's H.B. 850 (1999) established the stateside educational technology opportunity program to provide low-cost, state-of-the-art computers for New Mexico's classrooms.

West Virginia's S.B. 603 (2007) establishes the 21st Century Tools for 21st Century Schools, a technology initiative to replace, enhance and fund current technology programs in schools.

Partnerships
Hawaii's S.B. 885 (2007) directed the state department of education to establish a career/technical education program that will include study pathways in natural resources, graphic design, computer networking and management information systems. It also provided for creation of STEM academies and joint ventures between state education and the University of Hawaii.

Iowa's H.F. 604 (2013) amended Statewide Work-Based Learning Intermediary Network Program, the purpose of which is to connect business and education and offer work-based learning activities to prepare students for the workforce. It required the program to provide a one-stop place for students, particularly related to STEM occupations.

Alaska's H.B. 278 (2014) allowed the state education department to award a grant to a nonprofit to expand STEM for underserved and unrepresented middle school students.

Idaho's S.B. 1091 (2013) increased funding to Idaho Digital Learning Academy and allotted $150,000 for the development and maintenance of an Internet-based portal of available online K-12 or dual credit courses.

STEM Councils

Iowa's Executive Order No. 74 (2011) created the Governor's STEM Advisory Council to strengthen STEM education. It urged the council on postsecondary education to provide additional funding to those postsecondary education institutions that have partnerships with high school seniors enrolled in STEM and energy fields.

Maine's S.P. 490 (2011) established the STEM Council to develop strategies for enhancing STEM education, from kindergarten through postsecondary. That included reviewing research, planning for coordinating state leadership, developing initiatives to promote STEM education, devising strategies for career/technical education alignment and coordinating out-of-school programs with school-based programs.

Maine's S.P. 393 (2013) provided one-time funds to the STEM Council to carry out duties of the council and to establish the office of executive director.

Teacher Support

Iowa's S.F. 2321 (2012) added a new section that supports recruitment of STEM teachers abd divides the state into hubs that complement and leverage existing resources, including extension service asset, area education agencies, postsecondary institutions, informal education centers, school districts, economic development zones and existing public and private STEM partnerships.

Idaho's H.B. 626 (2012) implemented recommendation from 2011 that the state create a web-based clearinghouse of approved online classes, accessible to students, parents and schools.

Idaho's S.B. 1184 (2011) provided high school teachers with mobile computing devices beginning with the 2012-13 school year and all students with mobile computing devices by 2015-16. The state will pay for the repair, maintenance, security and support of the devices from the overall budget.

Maine's S.P. 393 (2013) provided one-time funds to the STEM Council to carry out duties of the council and to establish the office of executive director.

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