By Anita Simic Milas, PhD

Paradigm Shift in Education: Spatial Literacy

Remote sensing and geographic information system (GIS) technologies proliferate our mental capabilities of processing and combining spatial and textual information about various static or dynamic events and their interactions. An enormous amount of constantly accumulating remote sensing data evokes an urgent need for more remote sensing experts and for adding another dimension to the educational system in the U.S.A. and worldwide - Spatial literacy. The ability to process and analyze spatial data while addressing pressing environmental issues, is the fundamental form of literacy for experts in geoscience. The ultimate goal should be to promote the discipline of photogrammetry, remote sensing and geographic information systems (GIS) to enhance the understanding of the geospatial concepts, and to promote growing interest in the application of remote sensing by government, academia, and industry.

What are the Educational Gaps?

Integrating spatial literacy into the existing educational system is challenging. Remote sensing and GIS are subject to the existing obstacles of attracting students to the Science, Technology, Engineering and Mathematics (STEM) disciplines. High school students and their parents commonly perceive STEM fields as difficult and unrewarding.

The robust effort of the U.S. government to transfer remote sensing knowledge to K-12 students can be achieved only through the focused effort of experts, parents, teachers, graduate students and society. No simple solution answers the question "How to attract and keep students in Remote Sensing?" However, educational strategies that directly engage learners in the educational processes and techniques can increase the "STEM momentum".

The Cascade Education Model

While it is essential to engage high school students in STEM, children need to be even younger than high school age when they start learning about remote sensing. Thus, *parental expectation* plays a critical role in early learning. *K-12 teachers* further encourage students' curiosity and nurture their interest for STEM activity, like that of remote sensing. The knowledge transfer has to be envisioned in a cascading fashion where experts and university professors together with their university students educate both pre-service and in-service K-12 teachers who, in turn, emerge enthusiastic, knowledgeble and prepared to educate their students and other teachers. Some of the important components of the cascade model are:

- *Readiness of the teachers* to impart fundamentals of an academic discipline lays the foundation of success.
- *Peer learning* is a well-established concept where students learn from their peers while developing stronger self-esteem and better social skills through an active-learning.
- *Stimulating curiosity* about a student's spatial environment encourages the "what", "why", and "how" questions.
- *Interaction with industry and government experts* such as those from NASA/USGS/NOAA inspires students' interest and involvement in Earth and space science and provides them with an impressive depiction of possible achievements.
- *The 'learning by doing' concept* is the key component of active learning. To expose young students to problem-based learning at an early stage will improve their critical thinking and understanding.
- *Outreach and awareness about remote sensing,* through webinars and videos, inform and educate students, teachers, parents, young professionals and the public.

Recognizing some of the challenges and incorporating the components of the cascade model characterized was the focus of a recently accomplished project at Bowling Green State University (BGSU), in Ohio. The "*SPatial LITeracy - SPLIT Remote Sensing integrated research-educational approach to support surface water quality monitoring*" offered high

Photogrammetric Engineering & Remote Sensing
Vol. 84, No. 5, May 2018, pp. 239–240.
0099-1112/18/239–240

doi: 10.14358/PERS.84.5.239

school- and university-level students the opportunity to gain hands-on field remote sensing learning and research knowledge in an actual research scenario. This program was designed to help educate parents and K-12 teachers who could then contribute to creating a diverse and highly skilled future workforce in the field of remote sensing.

The project started with an exhibition that was open to the public called "SPatial LITeracy- *SPLIT through ART*" where students displayed over twenty visually-appealing remote sensing images. Each image was accompanied by its own story including information about remote sensing data and environmental issues. The goal was to spark the interest of students and the public in remote sensing through art. The event was advertised through various websites and the local newspaper (https://mobile.twitter.com/sentineltribune/status/913792707402878977/video/1).

Soon after the exhibition, the teaming effort between Mr. Roger Blevins (Huron High School, Ohio), Dr. Kristin Arend (Ohio Department of Natural Resources, Division of Wildlife), and Dr. Anita Simic Milas (BGSU), organized a series of field campaigns and educational events at the Old Woman Creek (OWC) National Estuarine Research Reserve, Huron High School and BGSU, where students and teachers learned how to acquire and process spectral information using the field spectroradiometer and UAV/drone. They derived spectral indices related to water quality using real data to map and correlate chlorophyll-a and total phosphorous in OWC. Knowledge was first passed from Dr. Simic Milas' graduate to undergraduate students and then, in separate sessions, to high school students and teachers.

As part of the project, a one-day workshop was organized at BGSU for the students and teachers of Huron High School and other local high schools. Mr. Roger Tokars and Mr. Rigoberto Roche of NASA Glenn Research Center, and Dr. Andrea Vander Woude from NOAA shared their knowledge about "*Monitoring Harmful Algal Bloom in Lake Erie*". Dr. Robert Vincent, Professor Emeritus of BGSU, presented his perspective on remote sensing research from his experience while working in academia and industry.

An experts-panel discussion, moderated by Dr. Simic Milas, focused on how to attract students into the field of remote sensing and how to keep them interested throughout high school and university. The panel comprised of an Associate Professor of Education, two experts in the remote sensing field, a high school science teacher with two of his students, and undergraduate and graduate students. The discussion underscored the importance of three factors for learning success: (1) Students must be provided with hands-on training and experience-designed projects in educational streams nowadays; (2) The educational system at universities should favor knowledge and interest over grade-based achievements; (3) Teachers should be additionally educated and more effective in passing remote sensing knowledge and enthusiasm about the field to their students.

The workshop concluded with another component of the cascading education model, a hands-on session where high school students and teachers had a chance to learn the basics of image manipulation and visualization. The outreach component was enriched by the YouTube videos and webinars created by the university and high school students (https://www.youtube.com/channel/UCkmhoMQihvhRb1I8DpQ2wNw).

All components of the SPLIT Remote Sensing project promoted each other. While the SPLIT exhibition event, websites and newspaper articles attracted teachers and students to the program, the field campaigns and hands-on tutorials helped them to understand remote sensing basic concepts. An active-learning and team-building atmosphere were a driving force behind the peer learning between the students. The interaction between the students and NASA experts motivated students to participate in the panel discussion. The YouTube videos and webinars have secured ongoing engagement of teachers and students in the field of remote sensing after the event. Overall, the SPLIT Remote Sensing project could be described as an effective cascade education model that helps instantiate spatial literacy of students, teachers and parents. Moreover, the SPLIT Remote Sensing educational approach empowers the geospatial community by attracting more young people who would take the drive towards more rapid development of the disciplines of photogrammetry, remote sensing, GIS, and other supporting geospatial technologies. Thus, the role of the remote sensing societies, such as the American Society for Photogrammetry and Remote Sensing (ASPRS) and consortiums such as America View, in promoting the same or similar educational models is critical.

Funding for this activity was provided by AmericaView through a grant from the U.S. Geological Survey, awarded in December 2013.

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