# INTERDISCIPLINARY CAP STONE PROJECTS PROVIDE AUTHENTIC CAREER EXPERIENCE DURING SOCIO-ENVIRONMENTAL SCIENCE INVESTIGATIONS (SESI) **USING A GEOSPATIAL CURRICULUM APPROACH** David J. Anastasio, Earth and Environmental Sciences



Alec Bodzin, Education and Human Services and Environmental Initiative; William Farina, Robson Martins De Araujo Junior, and Thomas Hammond, Education and Human Services; Kate Popejoy, PhD, PopejoySTEM LLC Dork Sahagian, Earth and Environmental Sciences; Breena Holland, Political Science and Environmental Initiative; Scott Rutzmoser, Library and Technology Services Example of a student Culminating Project to use Smart Growth **Excerpt from Valania Park Culminating Project** Support Materials Specific Objectives to transform Ward 12 by adding police stations and bus routes "Surfaces b. Click Legend. The Allentown Personal Crime Index layer contains statistics about major categories of personal and prop crime. 100 is the national avera An example legend is shown on the right. to make the area safer and more livable. Design, develop and implement seven SESI investigations and three projects. This included Another thing that we can do to help the urban heat island effect is choosing the right conducting a usability analysis with the GPS-enabled iPads for data collection with the surface types. surface materials such as concrete and asphalt have higher Each block on the map is a censu block. Click on a block. A pop-up window displays percent canopy cover and personal and proper proposed Collector App, using the ARCGIS.com interface for student analysis of data, and developing temperatures. Adding porous surfaces help because, when it rains porous materials crime data for that block (red boxes in the lower image). Scro down to see all data and graphs student learning materials to accommodate the differing academic ability levels and language allow water to pass through resulting in the evaporation of the water that cools Within your assigned area compa the different census blocks. Wha are some similarities and differences that exist between these areas? abilities in a diverse urban high school. the surface. Surfaces such as concrete, metal and glass can raise the temperature in 🖉 LANTA Bus Stops the park so choosing the right surface types is crucial. I ANTA Bus Rout Gather student data from all 9th grade students and from 9th grade control group 🗹 Allentown Boundary Plant Life 🛛 Allentown Wards - Boundar students in buisiness as normal instruction with our three attitudinal measures: In Valania Park, the trees are destroying the pavement and concrete. Because of this, 🛿 Allentown Wards - Fill Spatial Learning Attitudes Survey, STEM Career Interest Questionnaire, and Student Interest in Allentown Zoning 📴 🎟 🧏 🗖 🕅 we will need to replace the trees but trees do serve a purpose, trees help... ✓ Vacant Sites and Brownfi Science, Technology and Geospatial Technology (STEM-GEO) Survey. Reduce air temperature by blocking sunlight Video Tutorials Natural air conditioner Implementation of a hybrid form of professional development for the participating Fallen tree leaves can reduce soil temperature and soil moisture loss [[]] 📫 📻 🧲 🕥 Culminating Proj ^ ⊑ (€ ↓) <sup>11:48</sup> AM 5/8/2018 ₹ teachers designed to promote teachers' geospatial science pedagogical content knowledge. Trees absorb carbon dioxide and potentially harmful gases such as sulfur. Due to the stated above the trees will be removed due to the harm of the concrete. During this investigation, seven SESI investigrtions and three projects were built, pilot tested, and implemented. Each activity included Compedencies extensive instructor scaffoling. Here, we present results from the interdisciplinary Tree Planting and Culminating Projects. 2.4 I can apply a range of deliberative and democratic strategies and procedures to make decisions and take action in my classroom, school, and out of school civic contexts. Tree Planting Project 3.2 I can use map ,satellite images and other representations to explain relationship In this geospatial project, students were given a grant that will fund the planting of trees on the property of their school. They .... between the locations of places and regions and their political culture and economic dynamic.' The Winning Tree Planting Proposal and Narrative Excerpt . Developed a proposal to plant trees in at least two different areas on the property of their school using at least two different species. . Identified the different species that should be planted. 'My Tree Planting Proposal" - 9th grade science class assignment . Identified and explained the optimal locations to plant the trees. 4. Created a map in Web GIS that shows where the trees will be planted. "In this world trees are very important they help us in our daily lives without us even knowing. Have 5. Wrote a proposal that described their tree planting plan. you ever questioned why they are so important? You may know they help breath, but there's much . Students with strong proposals then presented their plans to a panel of judges, including school administrators and expert mentors. more to it. They are important to the natural and built environment because they are the biggest plants on earth and they give us lean oxygen, The winning plan will be implemented in the next school year. store carbon, help the soil, and give animals a home. To get clean oxygen it's because trees are like a filter to the earth. They take all the dust and absorb unnecessary things from the air and turn it into good clean air. As well they provide shade for us in any area they are at and help In the proposals, students for solar radiation and reduce noises from the world. To us humans trees and green spaces help reduce our blood pressure and make stress . Identified locations for the development of new commercial (business) areas with restaurants, groceries, and other service businesses. levels calm down which benefit our health. How they benefit our environment is by absorbing carbon dioxide as they grow which helps with 2. Identified locations for new park, green spaces, and/or and open space areas. global warming. They help with floods by absorbing thousand of liters of water from storms or when raining they slow down the fall reducing . Identified locations for quality new development for community resource needs. risk of flooding and reduce wind speeds by cooling the air. Not only do they help us but for Socially beneficial they help places look more 4. Created a new Web GIS map for their area to reflect their proposed changes. appealing and bring more people to places for example parks. When there are trees or geen life it looks more attractive to the eye." Culminating Project Project Scaffold Selection In this geospatial project, students were provided with a scenario that their city government is creating a new comprehensive plan for 1) Use motivating contexts and personally relevant and meaningful examples to engage learne How would adding trees to this area make it better? future sustainable development and is interested in smart growth. "If adding trees in this area it'll make it better because it will provide shade to others and the pavement. Since we go out in the summer for The comprehensive plan focuses on the following inter-related plan elements: gym outside it will help for the area to be cool and not so much heat from the sun. It will provide shade, help the soil, and absorb carbon Scaffold students to analyze geospatial relations . Energy and climate change reduction dioxide, and give us more clean oxygen."

### About Our Project

Inquiry-based investigations Map-based mobile data collection
Analysis with Web-based mapping software
Pedagogical frameworks of place-based education
and socio-scientific investigations
Local issues
Field work in the local setting
High-school level socio-environmental science investigations in the students' local community using a geospatial curriculum approach with STEM-related mentoring in high school classrooms comprised of under-represented students.
The research objectives designed to address the above goal include:
(1) Examine how socio-environmental science investigations and mentoring increase
students' interest in STEM and their motivation to pursue STEM-related careers.
(2) Analyze how the geospatial curriculum approach, when combined with STEM-related
mentoring, can improve STEM-related skills with students from groups that are
underrepresented in STEM.
(3) Investigate how STEM mentors perceive their mentoring experience in terms of
skill development, connection with youth, and personal satisfaction.

Fifteen mentors were recruited and worked with the students during the SESI investigations during the 2017-2018 school year to reinforce STEM career options.

Interdisciplinary team - interdiciplinary investigations

## Curriculum Approach



Develop geospatial learning activities in such a way that the software and hardwa become transparent to the user.

Visualizations are designed to be quick and intuitive for both students and teachers to use.

Novel form of hybrid professional development (PD), with both face-to-face and online learning.

Design partnership with classroom teachers.

Incorporates design principles in each investigation to promote geospatial thinkin and reasoning skills

2) Design image representations that illustrate visual aspects of social studies and Earth and

(3) Design web GIS data to make geospatial relations readily apparent.

Develop curriculum materials that better accommodate the learning needs of all students, while also expanding the geospatial pedagogical content knowledge of teachers.



4 teachers of 9th grade students Most students economically disadvantaged 21% English Language Learners 19% Individualized Education Programs 33% Unmotivated Learners-do not complete tasks, avoid challenging work



- 2. Park system and recreational opportunities
- 3. Transportation and safety systems
- . Economic development, commercial areas and tourism
- The students' goal was to incorporate one inter-related plan element into their city for making a ward and the city more environmentally sustainable. In science classes, students developed a presentation for their city that included smart growth principles and further promotes environmental sustainability. In social studies classes, students developed a presentation for their city that included smart growth principles and further promoted environmental, social, and economic sustainability.

As students developed their proposals, they were to focus on four or more of the following themes:

- Land use includes vacant land, brownfields, redevelopment opportunities, residential areas, commercial areas, and industrial areas. • Environment and Natural Resources – includes natural resources, floodplains and wetlands, carbonate geology and sinkholes, water quality,
- air quality, and brownfields.
- Transportation includes bicycle and pedestrian travel, public transportation, bus networks, parking, and highway and street networks. • Economic development - includes land and buildings, downtown revitalization, neighborhood commercial development, arts and culture.
- Neighborhood Conservation includes clean and safe environments, public services, amenities, and land use.
- Community Facilities includes parks and recreation, solid waste and recycling, health care, public buildings, and public safety.
- Housing includes housing and neighborhoods, assisted housing, and special needs housing.

# Examples of student artifacts from AY 2017-2018 for Tree Planting and Culminating projects



SESI materials are available https://eli.lehigh.edu/sesi/ Papers available at https://eli.lehigh.edu/publications/research





How do your choices take into account existing trees and other features around the school? "By planting these trees there it will improve the school look. Make it look even better and help to reduce hot temperature in the summer. Since we don't have a gym and go outside that will be a positive thing to us students. Where im planting these trees there aren't any other trees around which is why i decided to plant them there. By planting them neatly and putting mulch around them and on top it will make them and the school look clean and well put together."

Two doctoral students individually graded each student's submitted presentation using the Culminating project rubric. There were at total of 77 students included in the data. The rubric consisted of six individual grades, three related to Geospatial Data Analysis and three related to Geospatial Reasoning. Individual scores were assigned on a scale of 0 – 3 with a maximum score of 9 for each section and 18 total. There was a total of 462 individual grades and 396 were initiall identical resulting in an interrater reliability of 85.71%. The raters then discussed the remaining 66 grades and came to unanimous consensus. The unanimous grades are used to provide the data summaries below:

Student Summary - Total Project			Student Summary - Ge	•	n			n
Rating	Range	n (%)	Rating	Range	(%)	Rating	Range	<u>(%)</u>
Exemplary	16-18	5 (7.5%)	Exemplary	8-9	8 (11.9%)	Exemplary	8-9	6 (9.0%)
Proficient	10-15	22 (32.8%)	Proficient	5-7	31	Proficient	5-7	、 14
Adequate	4-9	29 (43.3%)			(46.3%)			(20.9%
Needs Improvemer	nt 0-3	11(16.4%)	Adequate	2-4	22 (32.8%)	Adequate	2-4	30 (44.8%
Did Not Complete		10	Needs Improvement	0-1	6 (9.0%)	Needs Improvement	0-1	17 (25.3%
			Did Not Complete		10	Did Not Complete		<b>`</b> 10

# Findings to Date

1) Strong growth in teacher's geospatial pedagogical content knowledge 2) Increased map use by teachers both within and outside SESI activities 3) Teacher use of maps as media for inquiry, not didactic instruction 4) Teacher modeling to guide students' analysis in GIS





## Data Summary for Culminating Project

