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Board 157: Design of a Geospatial Skills Camp for Rural Youth (Work in Progress)

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The Geospatial Skills Camps for Rural Youth will be hosted in June 2024 in eight locations in Montana. The Science Math Resource Center at Montana State University is designing a curriculum and one-week camp experience that will allow early high school students (rising ninth and tenth graders) to experience a STEM camp in their local area while still being connected to the research and experiences of a large R1 university. The camps will engage organizations that must be located in a rural area and also have the mission and capacity to reach youth who have been historically excluded from STEM, such as girls, racial /ethnic minorities, youth who would be first-generation college students, students from military families, youth from families without a lot of money, students from remote or rural communities, etc. Each organization will provide *community educators* who will run the camp curriculum designed by the research team. This paper details the camp curriculum design, including an analysis of a survey of geospatial professionals used to inform it. The curriculum will maximize local relevancy by allowing local community educators to choose themes relevant to their community.

Geospatial skills represent an excellent opportunity for high school students to connect to their local place and address local issues from a multidisciplinary lens[1]. Past camps and curriculum show that introducing students to these skills increases students understanding of climate change, spatial and relational thinking[2-4]. We also aim to address geospatial careers so that students can see the variety of careers that utilize geospatial skills across the state and the nation, particularly those connected to the US Air Force Office of Scientific Research and NSF EPSCoR as the funding agencies. We will highlight careers such as geospatial intelligence, geospatial engineering, forestry, and health geography.

Theoretical and Curriculum Design Frameworks

The sociotransformative constructivism theoretical framework informed the curriculum choices. Prior work on designing STEM curriculum for middle grade students has applied this framework to guide similar choices[5]. In applying this framework, we sought to ensure that the activities and assessments emphasized the elements of sociotransformative constructivism: dialogic conversations, authentic activity, metacognition, and reflexivity. To do this, we gathered initial information from the participating community educators through the application process (see description below) in order to inform the creation of authentic activities that reflect the skills of geospatial professionals contextualized to the locations of the camps. We hope to co-create some of the final versions of the curriculum alongside the community educators, by gathering data throughout the curriculum design process. We will also utilize resources from the NASA PLACES project to encourage educators to consider how they are communicating with students about data fluency in a place-based manner[6]. We will ensure our curriculum is place-based by addressing the five essential characteristics listed below, which will be used in training the community educators and developing the curriculum activities[7-8].

1. Its content focuses explicitly on the geological and other natural attributes of a place.

2. It integrates, or at least acknowledges, the diverse meanings that a place holds for the instructor, the students, and the community.
3. It teaches by authentic experiences in that place, or in an environment that strongly evokes that place.
4. It promotes and supports ecologically- and culturally-sustainable living in that place.
5. It enriches the sense of place of students and instructor.

In developing the specific lesson and inquiry sequence, we are applying the 7E instructional design framework which is an adaptation of the 5E curriculum structure[9-10]. In the 7E framework, students will be engaged by initial mapping activities to generate mental maps of their camp location or a chosen nearby location. The students will then participate in a series of explorations and introductions to geospatial skills related to mapping, as well as relevant data collection techniques. These explorations will emphasize the local environment and, where appropriate, will include activities that integrate local Indigenous knowledge. To do this, we will work with the community educators to determine how best to utilize local funds of knowledge. Our camp themes will include wildfire prevention and management, agricultural management, water quality, and air quality. Throughout the lessons focused on these themes, students will explore careers and here from experts how geospatial skills are used in engineering, military intelligence, agriculture and other industries. The final two days of the camp will allow students to elaborate on a community issue related to these themes that is of personal interest to them. The 7E lesson sequence has been designed to structure an inquiry for students while still affording community educators the ability to allow students to engage in locally relevant opportunities.

Data Collected to Inform Curriculum

Two sources of data served to inform the curriculum design and specific lessons chosen within the camp structure: a survey of geospatial professionals and the camp educator application. During the fall of 2023, a short survey was sent to geospatial professionals throughout Montana asking respondents to provide input for the camp's design. Additionally, during the application process, community educators were asked to provide suggested local issues that would be locally relevant to students and allowed us to narrow down our initial set of themes to the final set of themes of wildfire prevention and management, agricultural management, water quality, and air quality. The curriculum will continue to undergo refinement based on feedback from community educators during the training process that the community educators will undergo in order to present the curriculum.

Survey Results

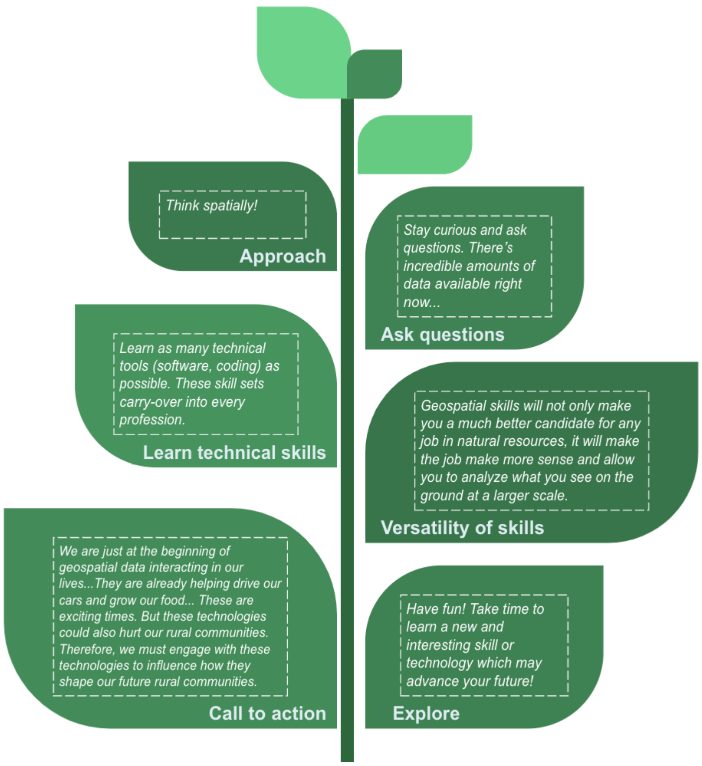
Given the need to develop the curriculum on a short timetable given that this is a one year project, the survey was open to geospatial professionals for 3 weeks. The authors sent the survey to our own networks, advertised within the university, and asked respondents to forward the survey in a snowball effort. Table 1 summarizes the top 3 skills the 20 individuals listed for their own career and the skills they would suggest for someone just starting in their career. These professionals came from across Montana and came from various industry sectors, including weed control management, environmental engineering, civil engineering, and water resources engineering. The respondents also included professors in education, environmental and human geography, landscape design, and geology. The survey helped to clarify specific skills that we would focus on during the camp. When asked to describe the skills that the professionals used, there were many references to data, GIS, and mapping. Additionally, respondents mentioned being familiar with at least one coding language. While several professionals responded with specific content that they work on, most referred generally to skills that could be used in multiple contexts, such as data visualization or graphing. Interestingly, when asked what top 3 geospatial skills they think someone new to the profession would need, the professionals were more likely to state “willingness to learn” or “being able to adapt/improvise”, or “a love for nature” than when asked to identify the skills they themselves use. The top skills did still emerge regarding data analysis and management and use of coding languages; however, there was less emphasis on the use of GIS specifically and more general references to mapping skills and remote sensing or image analysis. We will integrate these findings into the curriculum by establishing several activities early in the curriculum that will reference mapping, and image analysis will be integrated into the later aspects of the curriculum.

Table 1 Geospatial professional survey top skills

Question	Sample response	Response summary
What are the top 3 geospatial skills you use in your career?	Coding in R or Python with geospatial data (preparation, analysis, post-processing) GIS plotting and science communication Uninhabited Aerial Systems (drones) mapping	11 references to data analysis and data management 7 references to GIS 7 references to map creation 6 references to coding/use of computational skills 3 references to data visualization or graphing 3 references to remote sensing
What are the 3 most important geospatial skills for someone just entering your profession?	Computer skills Comfort working with/finding data Ability to improvise	11 references to data analysis and data management 9 references to coding/use of computational skills 4 references to mapping 4 references to remote sensing and aerial imagery 3 references to GIS

The geospatial professionals were also asked to suggest activities that might interest students engaging in a camp like this, as well as advice they would give camp participants. Figure 1 presents a visual representation of this advice as leaves on a branch. The italicized comments are samples from the geospatial professionals’ responses, and the bold statements are the codes represented by this advice. This advice will be shown to the community educators before the camp begins so that they can work with the curriculum team to determine the best method of presenting this advice. The ideas for activities have been used to provide additional opportunities for local community educators to choose activities tailored to their students' interests, which will be described below.

Figure 1 Advice to future camp participants



Curriculum Overview

As mentioned previously, the curriculum is organized as an inquiry experience that will include guest speakers and the opportunity to connect with local resources. The curriculum team is working to create overall student learning goals align with our geospatial professionals' responses. We will ensure the activities within the 7E lesson framework align to each of the overall objectives. Each day will begin with a hands-on activity that relates to an expert who will be presenting on their career and specific geospatial skills. Then the students will attend a virtual talk from a geospatial professional who will guide them through an activity related to their own work, so that students are not passive listeners but part of the learning process. Students will be encouraged to ask questions along the way and inquire about the expert's career. These experts will therefore come from a range of industry sectors and government agencies, to show the variety of future careers. The afternoon tasks will contain a collection of activities, some of which will be required for all camps to provide consistency throughout the camps. The consistency will ensure that during the live sessions students from different camps can be guided by the same expert. An example of a required engineering lesson is provided in the next section. There will also be several activities that community educators can choose from to allow each camp to respond to the interest of the participants. Given the geographic range of the camps across Montana, we have educators who have varied interests so we will enable the campers to create maps in the final days of camp that address their own community issue that they would like to highlight. We will encourage the community educators to allow students to help direct the activities chosen earlier in the camp so that they are more prepared to tackle their area of interest.

Description of the fire engineering task

Given that multiple camps expressed an interest in wildfire effects and management, we will engage all learners in a series of activities related to managing and preventing fires. Multiple experts are available to speak to the use of geospatial technology in fire and smoke science, particularly connecting to data science. The activity will integrate engineering design in that students will consider where to place a smart air quality sensor and how that sensor can be safely stored. This might include designing systems to integrate the sensor on a drone or other aerial system such as a kite. Students will be given multiple potential materials to house the smart sensors and will decide which material will work best to allow for data collection at multiple sites based on the mechanism of collection that they choose. Within this lesson, students will refer to aspects of the engineering design process that include defining the problem and design requirement, planning for and evaluating multiple design solutions, and optimizing the chosen design solution based on feedback from both the community educator and camp experts. These experts include electrical engineers who are working with our funding source, [redacted], to design smart optical sensors so that students receive authentic engineering feedback.

Measures to evaluate the project

Although this is a work-in-progress report, we hope to include various measures of success for this project that will aid in better understanding how short summer camps can be leveraged to increase student knowledge of STEM integration and student interest in future STEM careers. The project team will conduct both a process and outcome evaluation. We will evaluate attendance at the camp and the community educator training as a measure of process evaluation to measure dose delivered and received. We will also measure fidelity of implementation of the curriculum. For the outcome evaluation, we will measure community educator geospatial technological content knowledge and self-efficacy. We also aim to incorporate community educator definitions of success in their own camps as an evaluative measure, including asking the educators to consider what new knowledge of STEM broadly, and geospatial design specifically they hope to see in their students.

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