

# Examining Experiential Learning Impacts on Student Understanding and Skill Building through the Watershed Flood Modeling Project

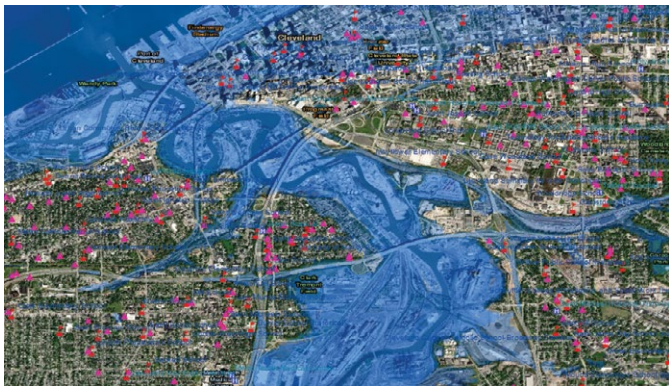
*Beth Szijarto*

## Abstract

Students collaboratively researched and designed an intelligent spatial map that helps predict flash flood damage for the Cuyahoga River Basin. Using Kolb's experiential learning theory, students were given the opportunity to build their skills, understand the connections between the classroom and community, and acquire knowledge. Middle school students developed real-world solutions by researching flash floods before constructing 3D models and geospatial technology. Statistically significant results suggested that there was evidence of an increase in learning and skill building. Students also increased their willingness to problem solve through complex issues and improved their application of technology skills by using 3D modeling and geospatial applications. As a capstone activity, a student leadership team was formed to present innovative prototypes of the predictive maps to the National Weather Service to offer solutions that help warn the public of flash floods.

## Introduction

As Planet Stewards, middle school students from both private, rural and suburban schools, Ashland Christian School and Saint Ambrose Catholic School respectively, believe that it is important to take responsibility to care for the environment. Educators within Christian schools have conveyed successful implementation of experiential learning methods in a school-wide capacity, including real-world problem solving (Hedin, 2010). Kolb's experiential learning is a cycle that utilizes different learning styles (Healey, 2000). By engaging with experiential learning, students learn how organizations work, engage in career exploration, and increase leadership skills with the ability to adapt to change (Lee, 2008). It has also been reported that self-directed learning and life-long learning skills emerge through experiential learning implementation (Jiusto, 2013). Other benefits resulting from Kolb's experiential learning theory include students' ability to better understand inquiry through authentic problems and reflection (Morris, 2020). Experiential learning has been reported to be effective through empirical research (Gosen, 2004). However, additional research is needed to study experiential learning by using a treatment and control group to further understand learning and effectiveness (Burch, 2019).



**Image 1.** The ArcGIS 10.0 (ESRI, 2014) flash flood model above demonstrated 3ft, 5ft, 10ft, 15ft, 20ft, 30ft and above simulation to help the National Weather Service understand flash flood vulnerable areas based on terrain. Photo Credit: Beth Szjarto

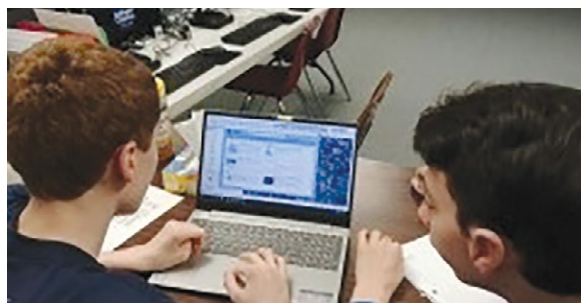
An experiential learning study was implemented through two schools that utilized a treatment engagement as well as a pre/post-test. Students met with one meteorologist and one hydrologist from the National Weather Service. These scientists worked with the children collaboratively to research and design an intelligent spatial map that helps predict flash flood damage for the Cuyahoga River Basin. Currently, the National Weather Service is not using a geospatial solution. Students implemented a spatial analyst model to predict the effects of rainfall on specific elevation levels using a digital elevation model (DEM) file. By using this model, the public might be able to make informed decisions for their safety. The National Weather Service has taken the simulated geospatial model and 3D prototypes as a suggestion that could be implemented in the future to help warn the public of impending floods.

## Desired Outcomes of the Project

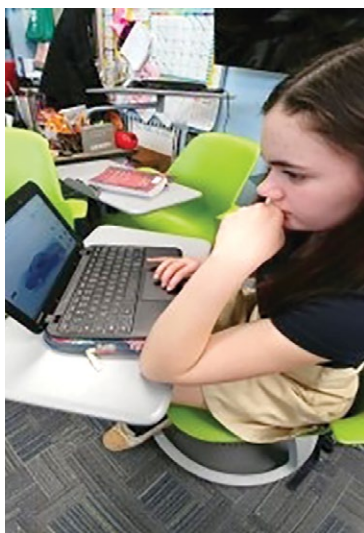
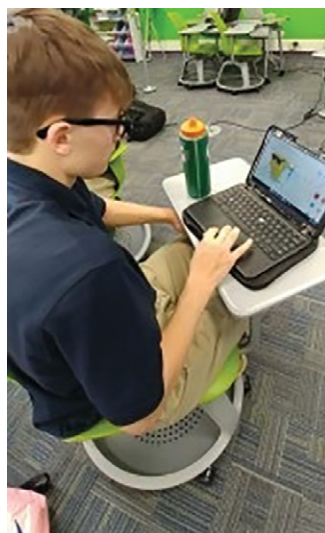
1. Private, suburban and rural middle school students engage in experiential learning to increase their knowledge, skills, and problem-solving approaches.
2. The prototype solutions help prepare citizens for potential flash flood damage, which could help save lives and residential/commercial property.
3. The National Weather Service may use the geospatial model to help warn citizens prior to any flooding. Currently, the NWS only calls citizens to inquire if they had flooding damage.

## Program Development & Implementation

Ninety middle school students completed a pre-survey assessment to create a baseline of current flash flood knowledge, tool usage, and problem-solving execution. Students selected which geospatial and 3D modeling tools they had used previously and were comfortable showing someone else how to use.



**Image 2.** Middle school students from Ashland Christian School develop prototypes that could help people survive a flash flood while in their cars without cell phones. Photo Credit: Beth Szjarto



**Images 3 and 4.** Middle school students from Saint Ambrose Catholic School developed prototypes that could help people survive flash floods. Students created cars with innovative extensions that filled with air to allow floating of vehicles, tools to break a window, and jetpacks to help people get out of their cars and fly away from the flash floods. Photo Credit: Beth Szjarto

Additionally, students were asked if they knew how to develop a solution to help prepare the public for flash floods. Overall, students were trying to solve the problem of how to create a geospatial model to warn the public of flash floods. Students also answered a secondary research question that focused on survival options for individuals in a car without a cell phone during a flood.

While students conducted research, they learned about weather careers and flash floods from a hydrologist through the National Weather Service. Students learned about the requirements needed for 3D and Geographical Information System (GIS) models. They began building 3D prototypes using TinkerCAD (TinkerCAD, 2021) and constructed ArcGIS (ESRI, 2014) geospatial layers (churches, residents, schools, hospitals, and businesses). Students engaged in developing a geospatial model by specific rainfall and elevation levels from DEM files and used spatial analyst extensions and math logic functions to produce flash flood predictions.



To assist with geospatial simulation construction, data was collected through a geodatabase, from within ArcGIS, where records coordinated locations for specific layer details. This data was collected for potential use by the National Weather Service that could help warn the public of rainfall levels according to elevation. Students took a post-survey assessment through Google Surveys to demonstrate that learning had resulted from the experiential learning treatment engagement.

This project allowed students to demonstrate proficiency in asking questions, developing and using models, and planning and carrying out investigations. The Next Generation Science Standards (NGSS, 2013) performance expectations highlight many societally relevant aspects of earth system science (resources, hazards, environmental impacts) as well as related connections to engineering and technology. Students were able to use the crosscutting concepts of stability and change as they designed a model to warn populations about flash flood hazards. This project most closely provides the development of skills associated with performance expectation of MS-ESS3-2: Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.

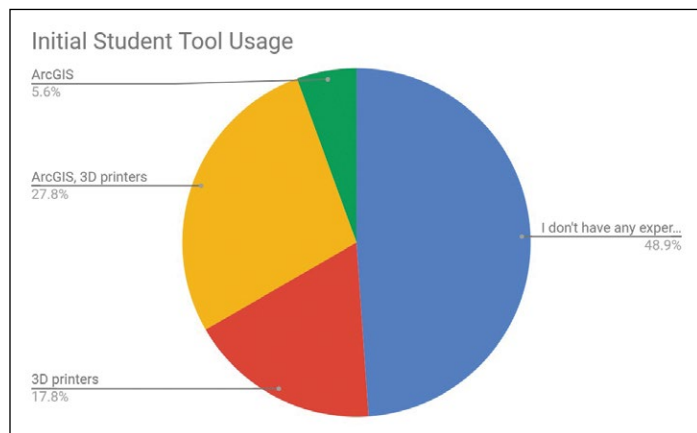
### Evaluation

Data collection methods consisted of using Google Surveys to obtain data about student experiences with flash floods, tool usage, and problem-solving approaches. 3D prototypes were constructed using TinkerCAD 3D modeling software. Geospatial layers were developed using ArcGIS 10.0.

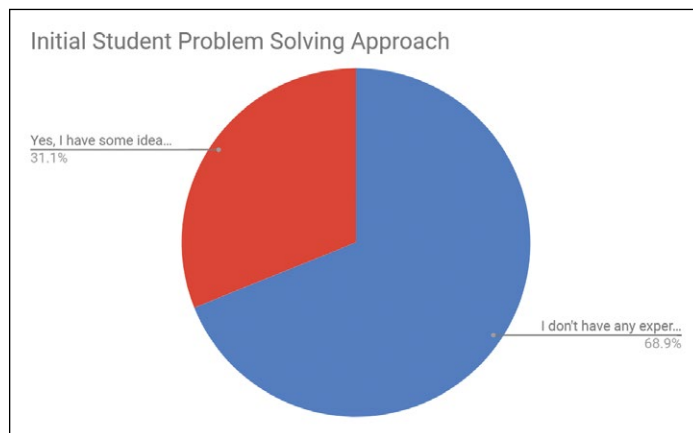
The null hypothesis (H0) is that experiential learning does not increase learning and skill building. The alternate hypothesis (H1) is that experiential learning increases learning and skill building. A paired two-tailed t-test was conducted utilizing pre/post survey data and GraphPad Software (2021). The paired t-test helped to predict the probability of growth in knowledge, tool usage, and problem-solving approaches, which resulted with a statistical significance (P value < 0.0001). Therefore, the null hypothesis (H0) was rejected. The paired two-tailed t-test was used as the statistical test

**Table 1. Outlines the type of data, collection method, and data amount that was obtained throughout the grant opportunity.**

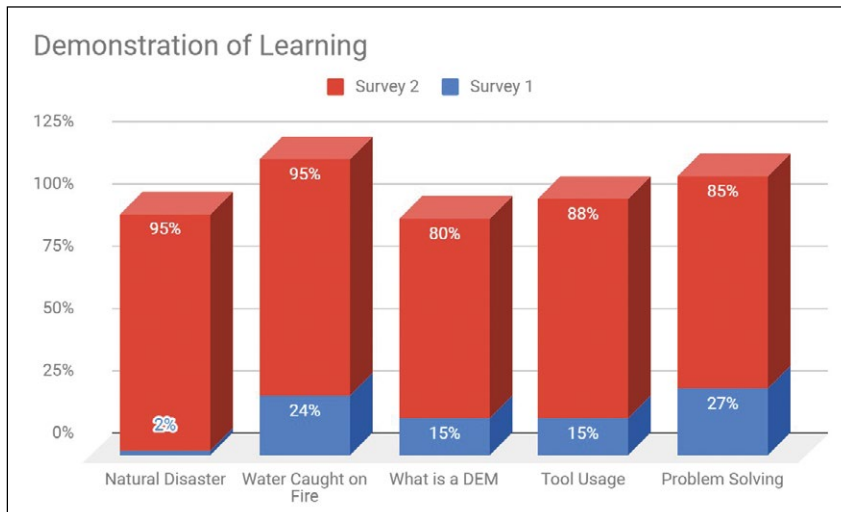
Student experience with flash floods	Google Survey	90 records
Suburban/Rural tool usage & problem-solving approach	Google Survey	90 records
3D prototypes	TinkerCAD	75 prototypes of individual/group developed 3D models
Church Layers	ArcGIS layers	Approximately 227,000 records
School Layers	ArcGIS layers	Approximately 208,000 records
Hospitals Layers	ArcGIS layers	Approximately 15,800 records
30 ft flood sample	ArcGIS layers	1 record polygon area
10 ft flood sample	ArcGIS layers	1 record polygon area
3 ft flood sample	ArcGIS layers	1 record polygon area



**Figure 1.** 28% of private school students who participated in the experiential learning study, reported tool usage experience with 3D printers and ArcGIS, while others reported only using 3D printers or ArcGIS. 48% of the participating students reported having no experience with these tools.



**Figure 2.** 31% of private school students believed that they knew how to solve the problem and had some ideas on how to accomplish the task. 68% of students initially reported having no experience or ideas on how to solve this problem.



**Figure 3.** Growth of knowledge between Survey 1 and 2.

a different result, ranging from 80% - 95%. This increase suggested considerable growth with each topic mentioned above for Survey 1. For example, student tool usage increased from 15% to 88%. Additionally, student results for problem solving approaches grew from 27% to 85%, suggesting that student creativity expanded through the experiential learning process.

## Conclusion

The Planet Stewards funded this opportunity for middle school students to conduct real-world problem solving. Students demonstrated that their stewardship project provided a solution to help residents and business owners prevent flash flood damage and death and build a better water-resistant structure to protect property, or move property to a different location. The creative 3D model prototype ideas could be used as solutions in the future to help individuals evacuate or survive a flash flood. As Planet Stewards, students demonstrated that they learned about flash floods and how to develop a real-world solution that was then provided to the National Weather Service, which may contribute to saving lives and prevent property damage. Overall, this experiential learning study enforced the importance of being a Planet Steward in private schools by fusing their understanding that it is their responsibility to take care of the Earth with their passion to help others within the community.

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because the subjects were the same participants for both the pre/post survey. The purpose of this test was to help predict the probability that the differences between the sample means occurred because increased learning and skill building likely resulted after students engaged in the “treatment” or experiential learning.

In Figure 3, students answered questions about flash floods, tool usage, and problem solving for both a pre/post survey. For Survey 1, students' answers ranged from 2% - 27% measuring knowledge of flash floods, past tools usage involving 3D modeling and geospatial technology, and problem-solving creativity. After students engaged in experiential learning and developed prototypes, Survey 2 data presented

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## About the Author

**Mrs. Beth Szijarto** is a doctoral student at Kent State University through Geography/Social & Behavioral Sciences. Her research involves studying competitive environments through rural and suburban schools by implementing prevention programming and utilizing experiential learning methods. She has a Bachelor's Degree in Management Information Systems and a Master's Degree in GIS/Remote Sensing. Since 2015, she has been a STEM Director for private, rural and suburban private schools, and has introduced geospatial technology to students and educators within Northeast Ohio. She worked in the corporate world for 15 years through quality assurance (QA) automation software testing and she has been an entrepreneur, launching educational businesses which promote STEM. She also used geospatial technology and computer programming while working for the federal government for 10 years. By getting the chance to engage with students through problem-based learning within STEM education, she often feels like a kid again. As a young child, she enjoyed adventure and reading *National Geographic*, *Discovery*, and *Choose Your Own Adventure* books. Over the years, she also participated in 4-H, Girl Scouts, Science Fairs, and Odyssey of the Mind competitions. She can be reached at [szijabe@yahoo.com](mailto:szijabe@yahoo.com).



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