Validity of Globe Observer Citizen Science By Utilizing an Experiential-Learning Model

Steve Garcia

STEM Enhancement in Earth Science: Summer High School Intern Program: Mosquito Mapper

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Abstract

Citizen science is a minimally tapped resource which could exponentially decrease costs dedicated towards research. There are countless amounts of hours required to be invested towards specialized research such as Mosquito Habitat Mapping yet the amount of hours available are already limited due to the minimal amount of trained researchers. Funds can't afford to train large amounts of volunteers, the most logical solution is to uncover when we can trust our Citizen Scientist's observations.

This study was conducted to test if an Experiential-Learning Model applies to Globe Observer Citizen Scientists, specifically Mosquito Habitat Mappers. Like many activities they are best learned through repetition and experience. Mosquito Habitat Mapping is tedious and it is expected that some data may not even be transferable. In order to validate the implementation of a more trusting Citizen Science procedure, research was conducted on the growth trends of ten users and their initial ten citizen mosquito habitat observations, to discover the minimal average amount of observations required for an individual citizen to output data with an accuracy score greater than 80%. After analyzing the accuracy of each individual observation and growth rate, it was discovered that a user will output an accuracy score of 80% or higher after 22 observations.

Keywords: citizen scientists, mosquito habitat mapping, Globe Observer, experiential-learning model

Research Question

How can Globe Observer Citizen Science be validated to ensure that it's large data set can be utilized in required research? As humans, much of our desires and endeavours are limited in solidarity because of time. Any specialized field research requires a large and unique data set depending on the researcher's individual question, which requires a large amount of funding to train volunteers to create the data set. Globe Observer is a government funded citizen science app which allows volunteers in Globe countries to contribute with specialized observations. Researchers conducting research on Mosquito Behavior, Land Coverage, Tree Growth, or Cloud Coverage should be able to turn to Globe Observers extensive data set, yet their skepticism on the validity of citizen science limits their outreach. Precisely the reason as to why this study analyzes the growth behavior in user observations for Mosquito Habitat Mapping, to uncover a positive growth trend correlated with experience.

Introduction and Review of Literature

Citizen science is an undetermined data set which many scientists are skeptical to depend on. Globe Observer Mosquito Habitat Mappers (MHM) are briefly trained and educated on the characteristics of distinct mosquito larvae development. It is required to complete this area specific protocol E-training which analyzes readiness through a controlled user observation. Upon the user completing the protocol training, they can begin conducting observations of Mosquito Habitats. Each observation goes through four required steps; identify potential mosquito habitats, sample and count, identify larva type, and eliminate.

The user first provides their accurate location, then identifies the possible breeding habitat category, with an attached picture. They are asked if they can observe larvae and are provided appropriate sources to verify. Then afterwards they are asked to count mosquito larvae and observe if eggs, adult mosquitoes, or pupae are present. Lastly Globe Observer requests magnified images of individual larvae for identification. MHM procedures are quite thorough yet are unable to prevent false observations, or even validate their accuracy.

As discussed by Lukyanenko et al. (2016), Citizen Science can be a promising source for an extensive data set, but currently a users' individual perspective creates bias in observations. Citizen Science in planetary body observations have the same faults as MHM observations since a citizen's lack of training doesn't allow for their individual bias to be suppressed. It is suggested that the utilization of Citizen Science be limited to categorization, yet in limiting the outreach of citizens they fail to take into account that with experience a growth in accuracy and a decrease in personal bias could be achieved. The physiological characteristic of learning must be taken into account when validating specific user observations.

In accounting the research of the Institute for Experiential Learning (2020), a greater accurate data output will most likely be achieved amongst later observations. As David Kolb

suggests, once knowledge has been transferred it is solidified amongst experiential learners through experience and reflection gaps (“What Is Experiential Learning,? ” 2020). Experiential learning can be further refined yet with a basic understanding of the model it can infer that there should be a growth trend correlated with experience, but the amount of MHM experience required to output accurate data is unknown.

Although Globe Observer Citizen Science is yet to be systematically validated, Gommerman and Monroe (2012) have demonstrated that voluntary Citizen Science is more likely to produce accurate observations. It was inferred that participants of Citizen Science programs are likely to volunteer if they have a preliminary interest towards the subjects of observation. That said following the same logic the majority of MHM from Globe observers should have an interest towards Earth Science and mosquitoes or their vector borne disease transmission. Like any activity these highly interested individuals will/may not conduct their first observations perfectly based on the Experiential Learning Model, yet their accuracy will improve through time.

Methodology

To observe an accuracy growth rate amongst user observations, Globe Observer Mosquito Habitat Mapping Observations from 2017-2020 were compiled on a spreadsheet. This data set was too extensive as all 19,277 observations were included even those whose users hadn't observed enough habitats to have sufficient experience for growth to arise. To ensure that an accuracy growth rate was observed amongst the right users, a filter was applied on the data set. "Super Citizen Scientists" (SCS) refers to the term describing Globe Citizen Scientists which have conducted ten or more observations. SCS were individually allocated into another spreadsheet because these specific users demonstrate the possible accuracy trend which an experiential learning model predicts.

Upon the completion of a filtered SCS data set, the observations were grouped together by user and date of publications. From the ordered SCS data set, ten users which had uploaded both images for water source and larva sample were selected, along with their initial ten observations. In acquiring the refined data set for this research, all 100 user observations were analyzed by accuracy and categorized by individual order of publication for users.

The accuracy of each observation was classified by weighing the users data for four specific categories each with distinct weight (Image Reference, Figure 1). "Accurate Water Source Type and Pupae Presence analysis " each account for 25% of the accuracy score; these are weighted more heavily since they directly contribute to the growth of mosquito populations. "Mosquito Egg Presence" is weighted at only 15% due to the inability for some citizens to observe non-culex mosquito eggs. "Usable Mosquito Larvae Images" are weighted the heaviest at 35% due to the high importance for researchers to collect usable larvae data to conduct the valuable research such as that from my fellow Mosquito Mappers. Keynote: Many users

deliberately chose to leave Mosquito Egg Presence blank. I took the elective decision to count that action with weight since it demonstrates that the user acts as a trained researcher, knowing their own limitations and preserving the accuracy of the data. Although a trained researcher would know how to observe Mosquito Egg Presence, the absence of these observations doesn't taint the accuracy of the results since all other categories can have the potential to be accurate.

Mosquito water sources are concluded as accurate if the image can be used to infer the type of water source. If the images are usable then the user's analysis is compared to the accurate categorization. Mosquito Larvae images are analyzed as accurate as long as one of the images provides a full body view of the larvae. All additional images which focus on either abdomen or tail are not weighted differently. For all images provided which are unfocused yet species type or water source can still be analyzed, they are weighted with half the equivalent weight for the specified category.

Although Globe Observer requires users to analyze more than four categories, these specific classifications were applied weight as they directly correlate as the preliminary method of classification for research data sets. In analyzing the accuracy score of water source and usable mosquito larvae images, those minimal observations alone can be utilized confidently by researchers to prove a numerous amount of theories. In obtaining accurate images, research can utilize them as raw data into which trained individuals can further classify the images.

Once the accuracy scores for all individual observations were acquired the average accuracy score for each ordinal number was obtained (Image Reference, Figure 2). Lastly the average accuracy score of the orindal observations was analyzed to obtain the average growth rate of user accuracy. Utilizing the average growth rate of user accuracy, the minimal amount of observations required for users to output an accuracy score of 80% or higher can be analyzed.

Results

After verifying each individual data from the users observations, their accuracy score was grouped to its corresponding order of observation, to analyze the average growth rate of user accuracy (Image Reference, Figure 3). The processed data demonstrates that on average the 10 users initially had continuously fluctuating accuracy readings until after the 5th observations which although demonstrated a lower local maximum, the accuracy score movement was more linear and almost tangent to the average growth rate (Image Reference, Figure 4). This demonstrates that the user wants to output trackable growth which directly correlates to the dependability of Citizen Science.

Further Discussion

My research is incomplete, currently I haven't discovered an absolute minimal average number of observations till a reliable accuracy score was achieved, but I did uncover a positive growth rate of user accuracy which indicates that an experiential learning model can be implemented upon Globe Observer Citizen Science analysis to demonstrate that after a 22 observations a user will output MHM observations with an accuracy score of at least 80%.

This study of course only analyzed the observation of 10 users and their initial 10 observations, upon testing a larger data set a more concrete accuracy growth rate can be attained. Moreover upon testing the accuracy of all Mosquito Habitat Mapper user analysis, the accuracy growth rate will be subject to change. This study was conducted to serve as a proof of concept for a more thorough observation of all SCS observations.

Conclusion

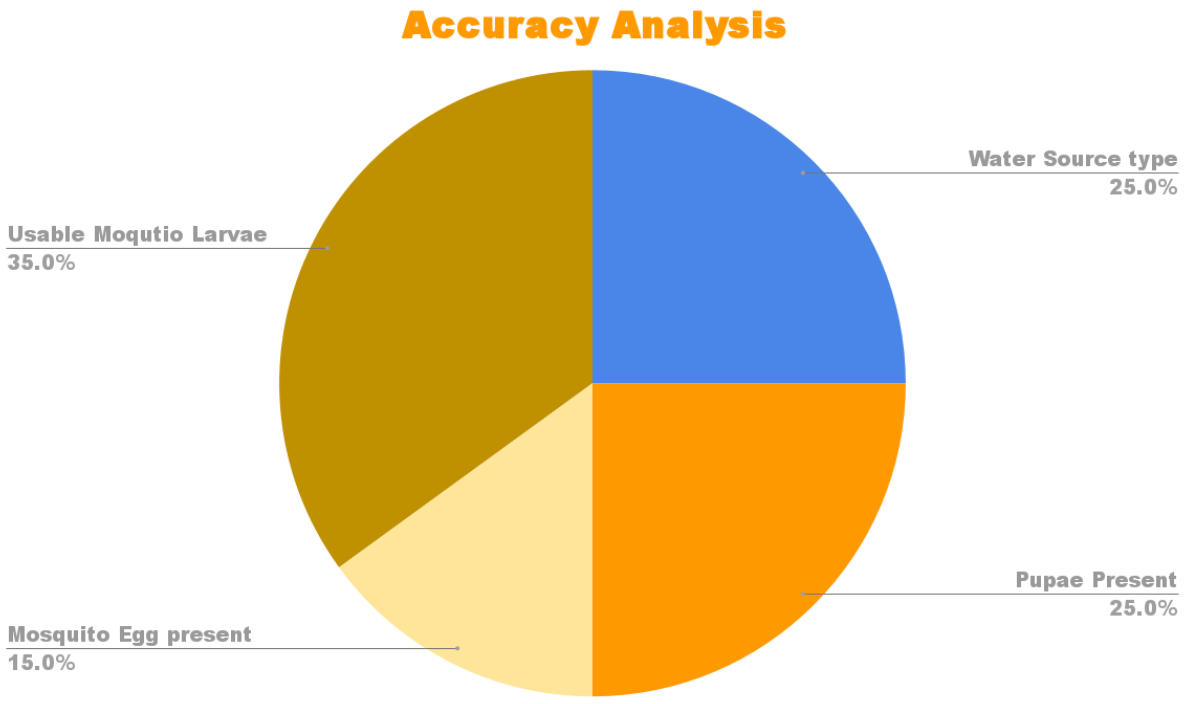
My research, although limited in data sets, demonstrated a promising accuracy growth rate, worth further studying to determine when Citizen Science data sets are a reliable source for official research studies. Researchers are correct in hesitating initial observations by citizen scientists but it has been demonstrated that experience amongst Mosquito Habitat Mapper observations increases the accuracy of analysis and data collection. Upon further research and a larger data set, a more accurate accuracy growth rate can be uncovered which can then be integrated in Globe Observer protocol to indicate the most accurate observations for research.

My project peer mentor, Dr. Rusty Low has greatly impacted my research as she was the first to break the news that Citizen Science is often ridiculed by professional scientists. Although Upon her breaking the news, there was an immediate reaction of responsibility and need for this paper to be published to ensure to researchers and invested citizens that Globe Observer Citizen Science is a valid resource which can be depended on.

Image Reference

Figure 1

Accuracy Weight Analysis in Classification of Citizen Scientists Observations



This pie chart demonstrates how each of the four categories is weighted to interpret the accuracy score of Citizen Science Data.

Figure 2

Individual Accuracy score Globe Observer Classification

observation	11114	2877622	2952065	8778715	26796100	13021259	50662377	6290868	45362486	49497468
1st	35	50	82.5	40	100	75	75	50	100	42.5
2nd	25	100	65	85	82.5	75	75	100	100	100
3rd	60	65	65	75	75	60	75	82.5	57.5	60
4th	35	75	82.5	85	82.5	50	100	100	100	100
5th	60	75	40	60	65	75	100	32.5	100	85
6th	60	100	65	57.5	57.5	35	100	100	82.5	60
7th	60	65	75	82.5	57.5	85	100	75	75	85
8th	65	65	82.5	75	40	75	82.5	100	100	75
9th	65	65	40	82.5	75	75	57.5	100	100	65
10th	100	75	65	85	65	75	100	82.5	82.5	82.5

This chart demonstrates the accuracy score for each individual user in order of the observation submission.

Figure 3

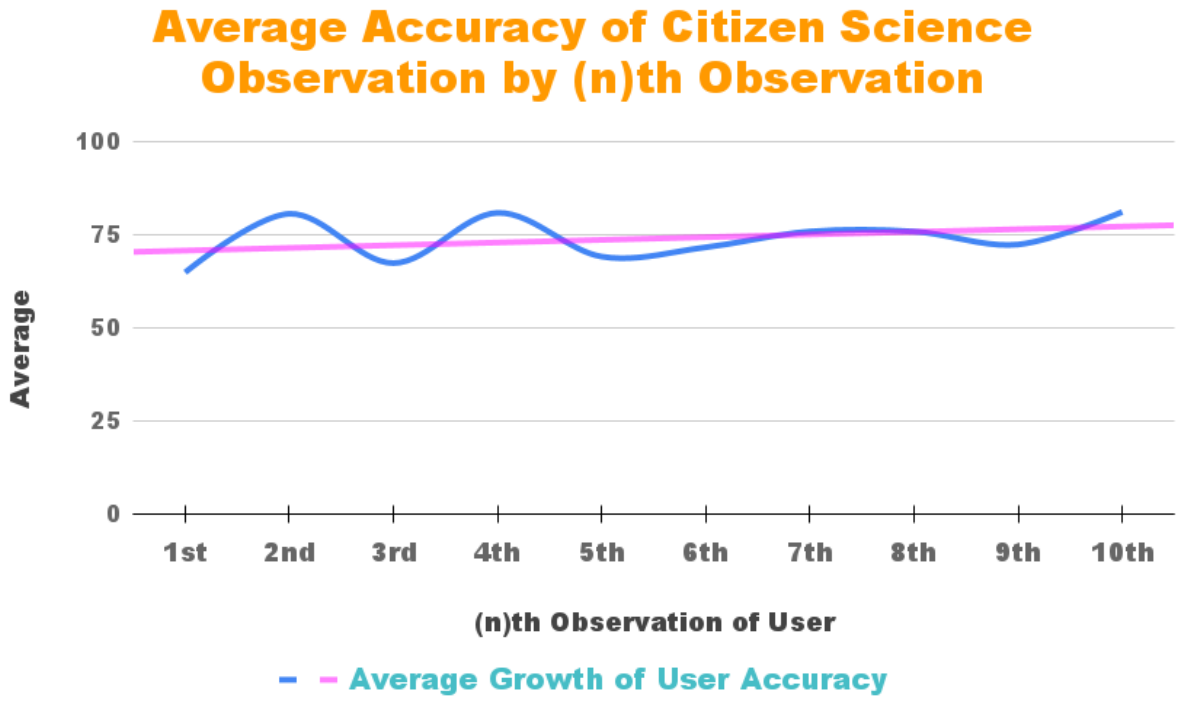
Average Growth Rate Evaluation

	Average	Growth
1st	65	
		5.75
2nd	80.75	
		-13.25
3rd	67.5	
		13.5
4th	81	
		-11.75
5th	69.25	
		2.5
6th	71.75	
		4.25
7th	76	
		0
8th	76	
		-3.5
9th	72.5	
		8.75
10th	81.25	
		0.6944444444

The growth of the average accuracy score of all data by orindal observations was calculated by taking the average of all growth behavior.

Figure 4

Line Graph of Accuracy Growth in User Observations



This graph demonstrates the average accuracy score of all ten users and their initial ten observations, included with the linear growth function amongst all observations.

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