

Integrating GPS Technology and Gaming as Tools for Improving Spatial Intelligence

Trina Halfhide¹, Luke Rostant¹ and Georgette Briggs^{1,2}

¹The University of the West Indies, Department of Life Sciences, St. Augustine, Trinidad and Tobago

²Arizona State University, Barrett, The Honors College, Tempe, AZ 85281, USA.

(trina.halfhide@sta.uwi.edu; luke.rostant@sta.uwi.edu;
georgette.briggs@sta.uwi.edu; georgette.briggs@asu.edu)

We developed an interactive assessment-based Geographic Information Systems (GIS) lab exercise for students enrolled in a Fundamentals of GIS course in an Environmental Science and Sustainable Technology (ESST) program. This lab exercise includes a GIS software data manipulation component and an active outdoor component - a Tree Hunt. Using Global Positioning System (GPS) enabled devices, students compete in independent groups to navigate to the trees via the GPS units. This combination of in-class and outdoor independent activities, facilitates active learning and requires students to draw upon and apply previously learned knowledge and skills in the form of a game. Overall, students can improve their critical thinking skills and develop increased spatial visualization skills. We provide an example of the lab and present alternative applications that can replace or supplement the use of a GPS unit for this activity.

Keywords: spatial intelligence, GPS, GIS software, gaming, active learning

Introduction

Spatial visualization, which can include the ability to imagine and design based on provided data, is one of the most beneficial spatial skills to acquire. The improvement of spatial skills has both theoretical and practical importance and can be used to predict aptitude in the science and technology fields (Uttal et al, 2013). This type of spatial intelligence is complex and is different from mathematical and verbal skills. These spatial skills are mastered and fine-tuned subconsciously, through everyday experiences which include dancing, efficiently packing the pantry, or navigating in an unfamiliar city.

Global Navigation Systems

Global positioning systems (GPS) was first developed in 1978 with the NAVSTAR US system, and today includes other positioning systems, such as the Russian Global Navigation Satellite System (GLONASS). GPS as a tool, has very broad

applications. In the field of biology, it allows, amongst other applications, the tracking and monitoring of wildlife, navigation to key points of interest in fieldwork, delineating habitats and discerning land use types, such as wetlands.

GPS operation requires three main segments, namely space, control and user (Figure 1). The space segment is represented by 4 satellites in 6 different orbital planes, for a total of 24 satellites. Each satellite orbits the earth twice daily, and is visible above the horizon for about 8 hours per day. Typically, between 4 and 8 satellites will be visible to the unobstructed user on Earth. The control segment is a network of ground stations responsible for monitoring the position and velocity of the orbiting satellites. These ground control stations periodically reposition the satellites, as gravitational forces can lead to orbital disturbances. These stations are distributed in different locations across the globe. When using a GPS enabled device, the accuracy obtained by the user is maintained by these stations. The final and most familiar segment, the

user segment, refers to the set of individuals (on Earth) with receivers. These receivers are usually small and have electronic screens that are mounted on larger moving components, such as planes and cell phones (Bolstad, 2016). The receiver records the data transmitted from each satellite, and the data is processed as three-dimensional coordinates.

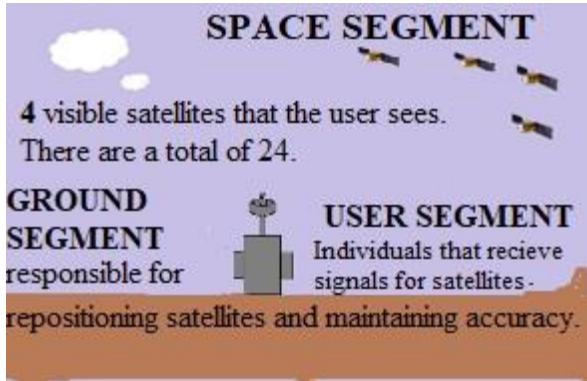


Figure 1: The three segments of the global positioning system [adapted from Bolstad, 2016]

Types of Data

In addition to the GPS data points (waypoints) used in this lab, students are also required to collect other types of data - attribute data. Attributes can be categorized into different forms: nominal, ordinal and interval/ ratio. Nominal attributes provide descriptive information, such as vegetation type, city name or soil type. There is no implied quantitative information in this data type. Ordinal data can also be descriptive, such as high, mid, and low, or it can be numeric. This data type inherently implies that a ranking or order can be derived from the data. Interval or ratio attribute data are recorded as real numbers and are often numeric in scale, such as area, length, height, and weight.

ArcGIS and QGIS Software

Geographical Information System (GIS) software like ArcGIS, assists users in storing, retrieving, managing, editing and analyzing spatial data. ArcGIS is the most widely used in the United States, however, it is a licensed product. An optional software, QGIS is free and more accessible, with compatible versions for multiple devices including tablets and cell phones. At the 2021 ViABLE meeting, we presented a modified version of the lab, using the free downloadable software QGIS. We have included the original lab in Appendix A, to demonstrate the use of the licensed ArcGIS software for the lab.

Use of Gaming in the Lab

Students start the lab exercise with a demonstration and interactive discussion on how to calibrate the GPS unit. [see link in Appendix C]. Student groups of 3-4 students are formed and each group is provided with 1-2 GPS units which have been preloaded with GPS waypoints. Students must use the GPS units to navigate towards each of the assigned trees numbered 1- 6. This portion of the lab, which involves the tree hunt, can be used to introduce game-based learning. Gaming is a widely accepted teaching tool that both stimulates and enhances active learning and motivation, leading to improved learning outcomes (Salen and Tekinbaş, 2008; Yang, 2019). Game-based learning arguably, is not utilized widely enough in the biological sciences.

For the competitive gaming activity, students can identify the most trees in a set time or figure out the most efficient way to access the trees. For this, we can score not only the points of interest correctly identified around the campus by the student groups, but we can also track the path taken by the students, grading the most efficient path with the highest points.

Following data collection, students then upload their data points using the ArcGIS or QGIS software. This portion of the lab allows them to understand through practice, how GIS data is generated and manipulated. If the tree hunt is done asynchronously, the lab-based QGIS database development and visualization components can present additional opportunities to include game-based learning components into the lab.

Broad applications of the lab

The post-lab survey (**Figure G** in the lab handout), conducted over a four-year period, allows us to capture and measure immediate learning from the lab exercise and to facilitate reflective practice in the development of this lab (Deslaurier et al., 2019). Generally, students indicated that the lab positively impacted their understanding of the creation of GIS data (Q5) and that the lab activity was enjoyable (Q7). Students mostly enjoyed using the GPS device to locate the trees and generally being outside of the classroom/lab for the tree hunt (Q8). We have consistently used responses from Q9, to reflect on the lab and to gauge improvements and enhancements from the student's perspective.

Overall, this lab exercise extends student thinking beyond content knowledge and has broad applications to introductory biology courses. It also highlights the application of current technology as an avenue to teach additional skill sets to students. The integration of GPS technology and the generation and manipulation of GIS data in the lab, is especially applicable for students engaged in fieldwork.

Student Outline

GIS 3006: Introduction to Geographical Data

Learning Objectives

- To collect data that is complementary to spatial data
- To gain a greater understanding of attribute data and types of data
- To gain a baseline understanding of Global Positioning Systems

While you may be working in groups for this lab exercise, you will need to submit individual word documents with your answers for this lab to myElearning. DO NOT FORGET TO PUT YOUR NAME, THE COURSE, AND THE LAB ON YOUR WORD DOCUMENT.

You will need to submit:

1. Your completed datasheet (**Table II**) with the coordinates, common name of trees, scientific name of trees, color of sticky note, quote, and author (6 points).
2. A screen capture of the plotted points from the navigation exercise, as well as a screen capture of the attribute data you collected (4 points).
3. A definition of attribute data as well as the types of attribute data you collected (5 points).

Introduction

This lab exercise is designed to give you a greater appreciation of spatial data collection. Spatial data refers to the X and Y coordinates used to reference a site or location. It refers to the data that can be mapped about a physical object and is represented by numerical values in a geographic coordinate system. We will be using latitude and longitude to locate points of interest on campus. This geographic reference is referred to as spatial data. You will also be collecting non-spatial data or attribute data at these points of interest.

Methods and Data Collection

Part A: The Tree Hunt - Locating Trees and Collecting non-spatial associated data

The latitude and longitude (Table I) that you are given should be used to locate the trees. This data has been loaded onto your GPS units. You are then responsible for providing additional information (Table II) about these trees. These tables are in x-coordinates and y-coordinates and can be converted to decimal degrees. The latitude and longitude degrees, minutes and seconds values can be converted to decimal degrees using the following equation:

$$\text{Decimal degrees} = \text{degrees} + \frac{\text{minutes}}{60} + \frac{\text{seconds}}{3600}$$

Table I: Locations of selected trees on campus

Tree number	1	2	3	4	5	6
Latitude	N ° 38' 33.3"	N ° 38' 27.7"	N ° 38' 28.9"	N ° 38' 29.9"	N ° 38' 30.4"	N ° 38' 32.2"
Longitude	W 61 ° 24' 01.3"	W 61 ° 23' 57.8"	W 61 ° 23'00.1 "	W 61 ° 24' 01.3"	W 61 ° 24' 01.1"	W 61 ° 24' 02.6"

Table II: Attribute data to be collected and completed

Tree #	Latitude	Longitude	Common name	Scientific name	Color of sticky	Quote's author	Quote
1							
2							
3							
4							
5							
6							

(6 points)

After completing Table II, please open an excel spreadsheet and input the collected data and the spatial data.

Importing data in QGIS and Visualization of waypoints in QGIS

Open QGIS and select the coordinate reference system - CRS as shown in **Figures A and B.**

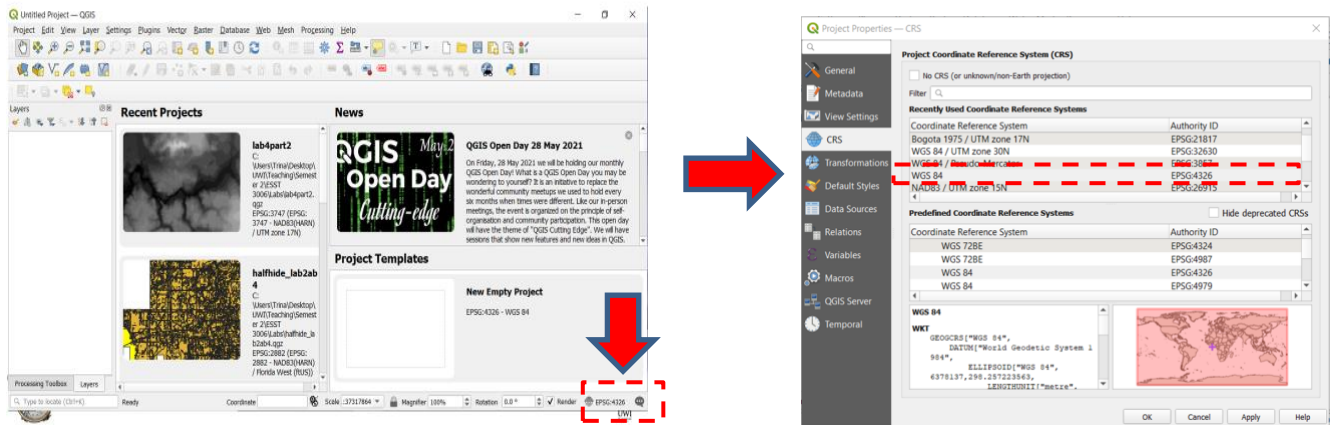


Figure A: QGIS window upon opening the program; select the

Figure B: Selecting WGS84 (EPSG 4326) coordinate reference system (CRS) as indicated by the red box>> Coordinate reference system (CRS).

Save your project in a folder in your C drive or desktop (**Figure C**). The simplest way to upload the points of interest is to add the GPX into QGIS. Go to 'Layer' on the top ribbon, Add layer>> Add vector layer (**Figure D**).

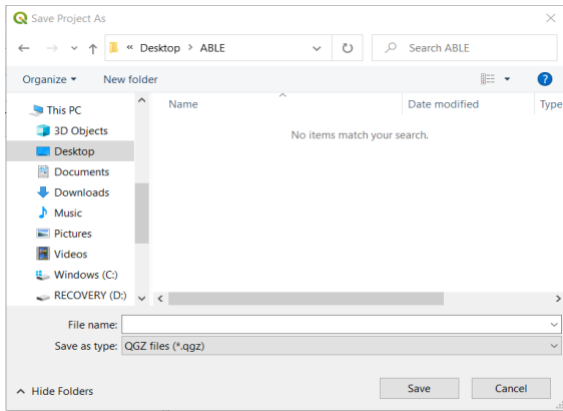


Figure C: Saving the project to your C drive or desktop

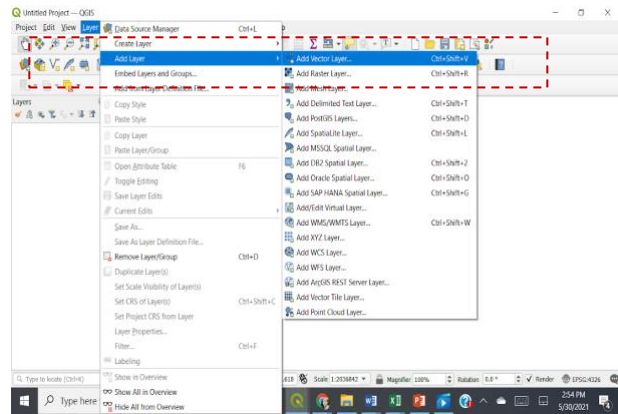


Figure D: Adding the point vector layer

Navigate to the folder where the GPX file is stored and then add the .kml file (**Figure E**). You should then see the waypoints on the map (**Figure F**).

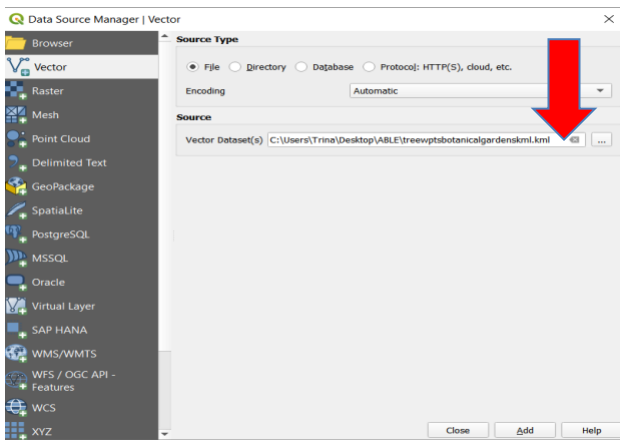


Figure E: Adding the point vector layer

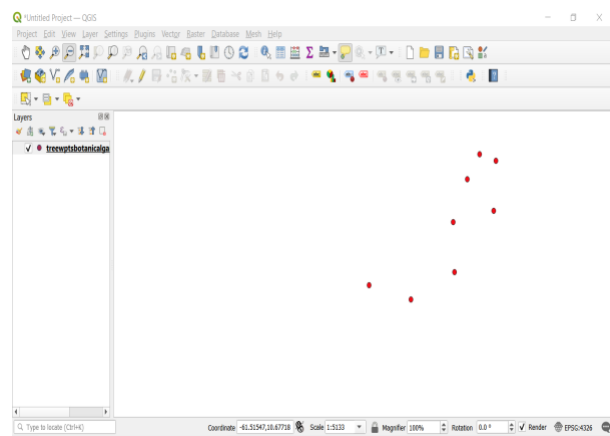


Figure F: Waypoints are uploaded and visible

Part B

Based on this lab exercise, **define and provide examples of** attribute data. (2.5 points)

What other data types have you noted? (2.5 points)

Please complete the questions and present a screen capture showing your trees represented as points. Submit as a word document. Complete and submit the survey at the end of the lab session!

Post-lab survey

1. Did you use the GPS unit in Lab 1?
 2. Were the trees easy to locate with the GPS unit?
 3. You were required to record spatial and other information about that geographic point, such as the species of the tree, the color of the sticky note, and the quote on the sticky note. The non-spatial information collected concerning that point is called_____.
 4. When you returned to the lab from the field, you were then required to open and add all of the information in an excel sheet. You then opened ArcCatalog and ArcMap to view the points and view the info associated with the six points. Do you think that this was an easy task?
 5. Do you believe that the exercise helped you gain a better understanding of how GIS data is created?
 6. Do you think that having created data in your first lab you would be more likely to do a project where you can create your own data for future projects?
 7. Did you enjoy this lab exercise?
 8. What aspects of the lab did you enjoy the most?
 9. Do you have any recommendations for improving the lab?
 10. Do you have any additional comments or concerns?
-

Figure G: Post- lab student survey questions can be delivered via SurveyMonkey

Materials

The simplicity of the lab design allows flexibility in the required materials and equipment. For marking the waypoints, a roll of flagging tape or twine is required. A GPS unit or phone with internet or data access are also important to set-up waypoints and to locate the tagged trees (or objects) for the hunt. The sticky notes of different colors (if possible) are useful, since this increases the attribute database. Use trees or other points of interest depending on your environment and alignment with your class topic. For the software component, a computer with internet access is needed to transfer the .GPX files to the other GPS units for students' use. Additional computers will be needed for the indoor lab-component to be completed by the students.

Notes for the Instructor

This lab was designed for third year university students in an environmental science program. In the context of the program, students registered for this course would have some familiarity with Microsoft Excel used to teach basic database development and management skills. Although this course is a final year course and most students have completed, it could be easily modified to accommodate students at other levels, once students have some technical competencies in data collection and interpretation.

Student Preparation

This introductory lab exercise aims to increase the spatial visualization skills, database development, and critical thinking ability of the students. Prior to the lab, students are given a lecture on GPS. This lab session is interactive and informative, and students are divided into groups of 3 with a maximum class size of 30 students. The group members are encouraged to work collaboratively with each other for both indoor and outdoor components, and friendly competition is encouraged among groups to boost team morale and efficiency.

Items to prepare before the Lab

Although the lab is simple to execute, it does require some prior set-up. Give yourself at least one week to prepare the lab prior to this designated lab time.

Preparing tags and marking waypoints

The waypoints will be tagged with flagging tape and a quote on a piece of paper. Prepare your excel sheet

with a database of quotes and authors. Use colorful sticky notes to write the different quotes and authors on each piece of paper. You will also need to punch holes in the notes for attaching to the flagging tape (Figure 2).

For this lab exercise, the trees on the university campus were used as navigational points of interest (waypoints). As a modification of the lab, these points of interest can represent other sites, items or locations including campus monuments, buildings or other relevant biotic specimens.

Walk around campus and start to create the database with waypoints representing tagged sites of interest. Select your tree, record the coordinates on the GPS unit and tag the tree with flagging tape (Figure 3). A detailed step-by-step guide for using the Garmin62SC GPS unit to record GPS coordinates are included in Appendix B.

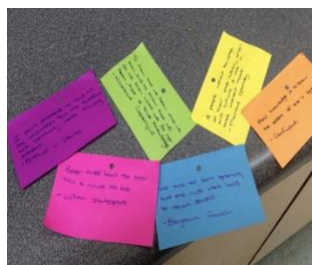


Figure 2: Sticky notes



Figure 3: Tagged tree prepared with flagging tape

Loading the waypoints on additional GPS units

After marking and tagging all the trees (sites of interest) and noting their coordinates, the data has to be shared for the lab. To do this, load the waypoints into the other GPS units by connecting via USB to the other Garmin units. You can then copy and paste the GPX file into a named GPX folder, and then disconnect the GPS unit. An alternative is to email the waypoints to the students as a GPX file if using the Gaia GPS app option for GPS navigation. Gaia GPS is a free app (Appendix C). This would also allow students to independently access the points and

asynchronously load them on their smartphones for later use.

Preparing Lab computers - Uploading GIS software

GIS software should be loaded on the student computers. If you are not able to use ArcGIS or if students are working remotely, freely available QGIS software with support can be downloaded at:

<https://qgis.org/en/site/forusers/download.html> and uploaded to student devices.

At the start of the lab session

At the beginning of the lab exercise, students are given an abridged lecture on GPS, including how to calibrate and navigate to points of interest using the GPS units, and the types of data that will be collected. We typically determine the student working groups and as a class, review the instructions for the exercise.

Navigating to the marked trees

This is the Tree Hunt and represents the gaming aspect of the lab exercise. Here you are free to introduce some competitive elements to motivate your students to accurately and efficiently complete the navigation to the marked trees. A short tutorial on navigating to the marked trees can be found at <https://youtu.be/buAeJ31mTh4> (Appendix C). When students locate each marked tree, they must record all the data associated with it as guided by **Table II**.

Importing data and Visualization of Waypoints

When student groups return to the lab session they should continue to use the lab handout and should input the collected data and the spatial data into a new Excel spreadsheet. Students continue to follow the instructions on the handout that guide them on how to import their data and use QGIS to create a GPS exchange format (GPX) file. The created GPX file is then used to create a map to visualize the waypoints using the GIS software.

Preparation of items to submit

To complete the lab exercise, students must submit the completed datasheet (**Table II**); a screen capture of the plotted points from the navigation exercise; as well as a screen capture of the attribute data collected. Both questions on **Part B** of the lab handout should also be included as part of the submission.

After the lab session

This lab was conducted for four consecutive years and received positive feedback from students. The student survey instrument contains the questions listed in **Figure G** of the lab handout and is conducted post-lab on a voluntary basis. Although the activity is voluntary, we have received excellent participation and response rates from our students using the feedback survey tool, with response rates between 2016 and 2019 at 70%; 94%; 73% and 82% respectively.

This lab exercise facilitates active learning and increased spatial intelligence. The lab can be modified to be completely remote and asynchronous using some freely available mobile applications described below. We introduce two specific applications, *iNaturalist* and *Gaia GPS*, that can be downloaded for both iOS and Android devices.

iNaturalist

iNaturalist is a freely available and downloadable application for your computer or mobile device. It is a social platform that allows for the mapping and identification of biological observations. Although widely used as a citizen science tool for City Nature Challenges or BioBlitz surveys, it is underused as a tool in the classroom. When incorporated into the lesson, it allows students to be actively involved in learning outside of the classroom, applying skills previously learnt, and collecting data to contribute to a larger body of work. For the faculty, it allows flexibility in the course offering and can introduce stand-alone projects that students continue outside of class.

For this lab, *iNaturalist* can be incorporated into the lab preparation. When setting-up the tree-hunt, *iNaturalist* can be used when identifying trees to tag. When you capture an image of the tree you wish to use, the program provides positional coordinates. The community can assist in identifying the tree by its scientific name, which adds attribute data to your database.

Alternative GPS App - Gaia GPS

If instructors and students do not have easy access to GPS units, one useful application that can be downloaded and installed onto smartphones is Gaia GPS. Instructors can use this application to obtain the coordinates of points of interest on their campus and input these coordinates into a .csv file format in Microsoft Excel. The freely available software program QGIS can be used to create a GPX file which can then be emailed to all students. Students can open the GPX file on their smartphones using the Gaia GPS app. A demo tutorial on the use of Gaia

GPS can be found in Appendix C and can be viewed via this link:

<https://www.youtube.com/watch?v=4xAU8K9ypl8>.

Gaia GPS utilizes the map application on the smartphone, such as Apple Maps, or Google Maps. When students select a point of interest, they can choose to navigate to these waypoints in a manner similar to using a handheld GPS.

Alternative (Asynchronous) Format of the Lab

Using the alternative GPS mobile app - Gaia GPS, along with other mobile tools like iNaturalist, increases the scope and versatility of this lab exercise. Removing the requirement for a regulated device and replacing it with personal accessible options on the phone, allows students to take more ownership of the activity. This also opens up the ability to offer an asynchronous portion of the lab where students on their own time can navigate to the points of interest using their personal devices. Students can additionally use the iNaturalist app to identify the scientific name of the tree and confirm waypoints.

This option can be applicable to evening classes as well and could allow the splitting of the activity into two consecutive sessions. At the end of the first session, students navigate on their own to the points of interest and create their Excel file. At the start of the second session, students upload and convert their file to a GPX file and follow the steps to creating their maps and visualizing their waypoints.

Cited References

Bolstad, P. 2016. GIS fundamentals: A first text on geographic information systems. Eider, Press Minnesota.

Deslauriers L, McCarty LS, Miller K, Callaghan K, Kestin G. 2019. Measuring actual learning versus feeling of learning in response to being actively engaged in the classroom. Proceedings of the National Academy of Sciences 116 (39). 19251-19257; DOI: 10.1073/pnas.1821936116

Salen, K. and Tekinbaş, KS. (Eds.). 2008. The ecology of games: Connecting youth, games, and learning. MIT press.

Uttal, DH., Meadow, NG., Tipton, E., Hand, LL., Alden, AR., Warren, C and Newcombe, NS. 2013.

The malleability of spatial skills: a meta-analysis of training studies. Psychological bulletin, 139(2), 352.

Yang, HC. 2019. Education First: Promoting LGBT+ Friendly Healthcare with a Competency-Based Course and Game-Based Teaching. International Journal of Environmental Research and Public Health, 17(1), 107. doi:10.3390/ijerph1701010

Acknowledgments

Thank you very much to all of the GIS3006 students and teaching assistants who have helped improve this laboratory exercise over the last four years.

About the Authors

Dr. Trina Halfhide (Presenter) has been an Instructor and Lecturer at The University of the West Indies (UWI) since earning her PhD in Engineering Sciences with an emphasis on Civil and Engineering from the University of South Florida. She earned her Certificate in University Teaching and Learning in 2018, and teaches Environmental Science both at the graduate and undergraduate levels. Her educational research focuses on active learning and student engagement in STEM.

Dr. Luke Rostant (Presenter) has been an Instructor and Lecturer at The University of the West Indies (UWI) since 2011. He earned his PhD in Interdisciplinary Ecology from the University of Florida, with an emphasis on GIS and Remote Sensing. He attained a Teaching Award in 2015. He is the coordinator of the MSc. Biodiversity Conservation and Sustainable Development in the Caribbean, and is passionate about utilizing participatory approaches in learning and GIS applications in wildlife research.

Dr. Georgette Briggs (Presenter) has been a Lecturer at The University of the West Indies (UWI) since August, 2008. She earned a MEd in Curriculum (2013) from The UWI and has since been heavily involved in curriculum development, course design and the Scholarship of Teaching and Learning (SoTL). She currently holds a Senior Lecturer and Honors Faculty Fellow position at Barrett The Honors College at Arizona State University. Her research in science education involves the use of technology in the classroom and the integration of research in the undergraduate experience.

Appendix A

GIS 3006: Introduction to Geographical Data

Learning objectives:

1. To collect data that is complementary to spatial data
2. To gain a greater understanding of attribute data and types of data
3. To gain a baseline understanding of Global Positioning Systems

While you may be working in groups for this lab exercise, you will need to submit individual word documents with your answers for this lab to myElearning. **DO NOT FORGET TO PUT YOUR NAME, THE COURSE, AND THE LAB ON YOUR WORD DOCUMENT.** You will need to submit:

- 1) **Your completed datasheet (Table 2) with the coordinates, common name of trees, scientific name of trees, colour of post it note, quote, and author (6 points).**
- 2) **A screen capture of the plotted points from the navigation exercise, as well as a screen capture of the attribute data you collected (4 points).**
- 3) **A definition of attribute data as well as the types of attribute data you collected (5 points).**
- 4) **The completed conversion of coordinates in DMS to DD (Table 4) (5 points).**

Section A

This lab exercise should give you a greater appreciation of spatial data collection. Spatial data refers to the X and Y coordinates used to reference a site or location. It refers to the data about a physical object that can be mapped and is represented by numerical values in a geographic system. Geographic coordinates are in latitude (which runs north to south) and longitude (which runs east to west). When we take these 3-dimensional coordinates and project this onto a 2-dimensional plane we get a projected coordinate system. These can have several different units, but the one most commonly used is that of the Universal Transverse Mercator (UTM) system which is measured in metres. The co-ordinate data (Table 1) that you are given should be used to locate the trees. This data has been loaded onto your GPS units. You are then responsible for providing additional information (Table 2) about these trees.

Table 1: Locations of selected trees on campus in UTM

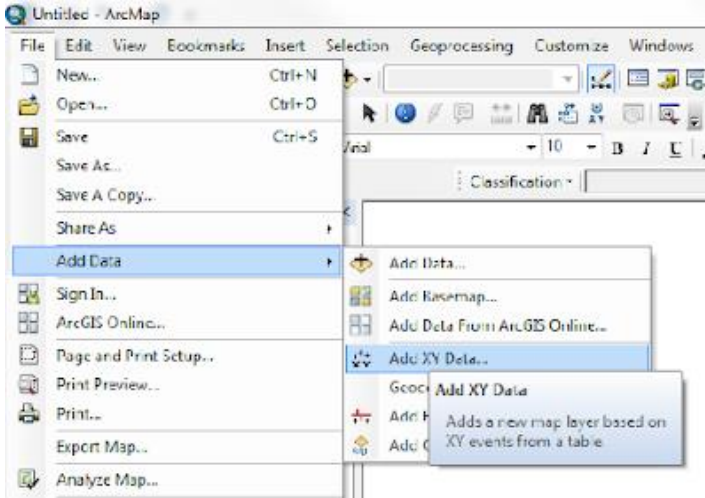
Tree number	1	2	3	4	5	6
Easting	674978	675011	675017	674980	674990	674938
Northing	1176913	1176779	1176811	1176823	1176851	1176874

Table 2: Attribute data to be collected and completed

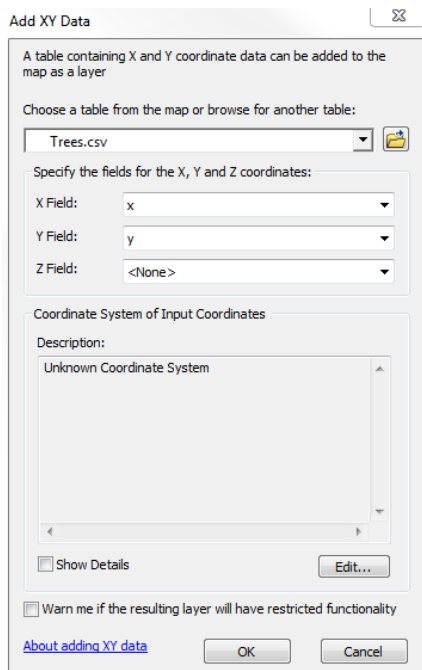
Tree #	Easting	Northing	Common name	Scientific name	Color of sticky	Quote's author	Quote
1	674978	1176913					
2	675011	1176779					
3	675017	1176811					
4	674980	1176823					
5	674990	1176851					
6	674938	1176874					

(6 points)

After completing Table 2, please open an excel spreadsheet and add the collected data and the spatial data. Please ensure to save the file as a .csv file. Ensure that there are no spaces when you are saving the file name. Open ArcMap, and click on File > Add Data > Add XY Data



Navigate to the csv file you created by clicking on the browse button to the right of the dropdown menu. Under “Specify the fields for the X, Y and Z coordinates” set the X Field as X (or Easting), and the Y Field as Y (or Northing). We’re not going to bother to set the Coordinate System for the purposes of this lab.



Produce a screenshot of the tree locations in QGIS and another of the attribute table for this data you brought in.

(4 points)

Section B

Based on this lab exercise, **define** attribute data (2.5 points).

What different data types do we have? (2.5 points)

Section C

Please show all working for the conversion for DMS to DD for the coordinates in Table 3:

Table 3:

Latitude (DMS)	Longitude (DMS)	Calculations Latitude	Calculations Longitude	Latitude (DD)	Longitude (DD)
10° 38' 32.1"	-61° 24' 2.66"				
10° 38' 33.38"	-61° 24' 1.31"				
10° 38' 30.44"	-61° 24' 1.26"				
10° 38' 31.37"	-61° 24' 0.95"				
10° 38' 30.05"	-61° 24' 0.05"				
10° 38' 29.01"	-61° 24' 0.25"				

(5 points)

Appendix B

Step-by-step Instructions for use and set-up of the Garmin 62sc unit.



Figure 1: Garmin 62sc unit, and associated buttons.

- a. Ensuring the teacher or instructor is outside and away from tall buildings, turn on the GPS unit by holding down the power button on the top right hand corner (Figure 2).



Figure 2: location of the power button on the Garmin 62sc unit

- b. The unit screen should switch on and the unit will begin searching for satellite signals. Navigate through the GPS unit by pressing the “page” button until you get to the main menu (Figure 3).



Figure 3: Navigating through the different pages of the Garmin 62sc unit - keep pressing the “page” button until you get to the Main Menu (shown in the figure).

- c. Using the toggle button in the Main Menu page, scroll down to the Satellite page, and once highlighted press Enter (Figure 4).

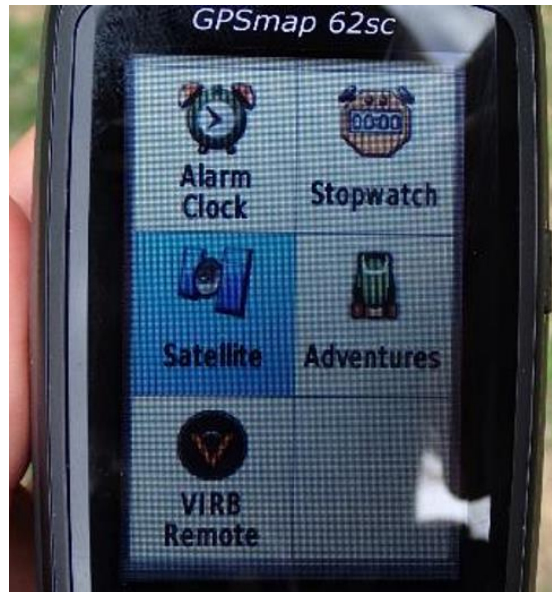


Figure 4: Navigating to the Satellite page in the Garmin 62sc unit

- d. Now in the satellite page, the unit will tell you which satellites can be “seen”, which satellites it is collecting positional information from (empty bars at the bottom of the screen), and which satellites it has already received information from (solid bars). Once there are 4 solid bars at the bottom of the screen, the GPS unit is working properly and able to provide you with the coordinates of your location (Figure 5).

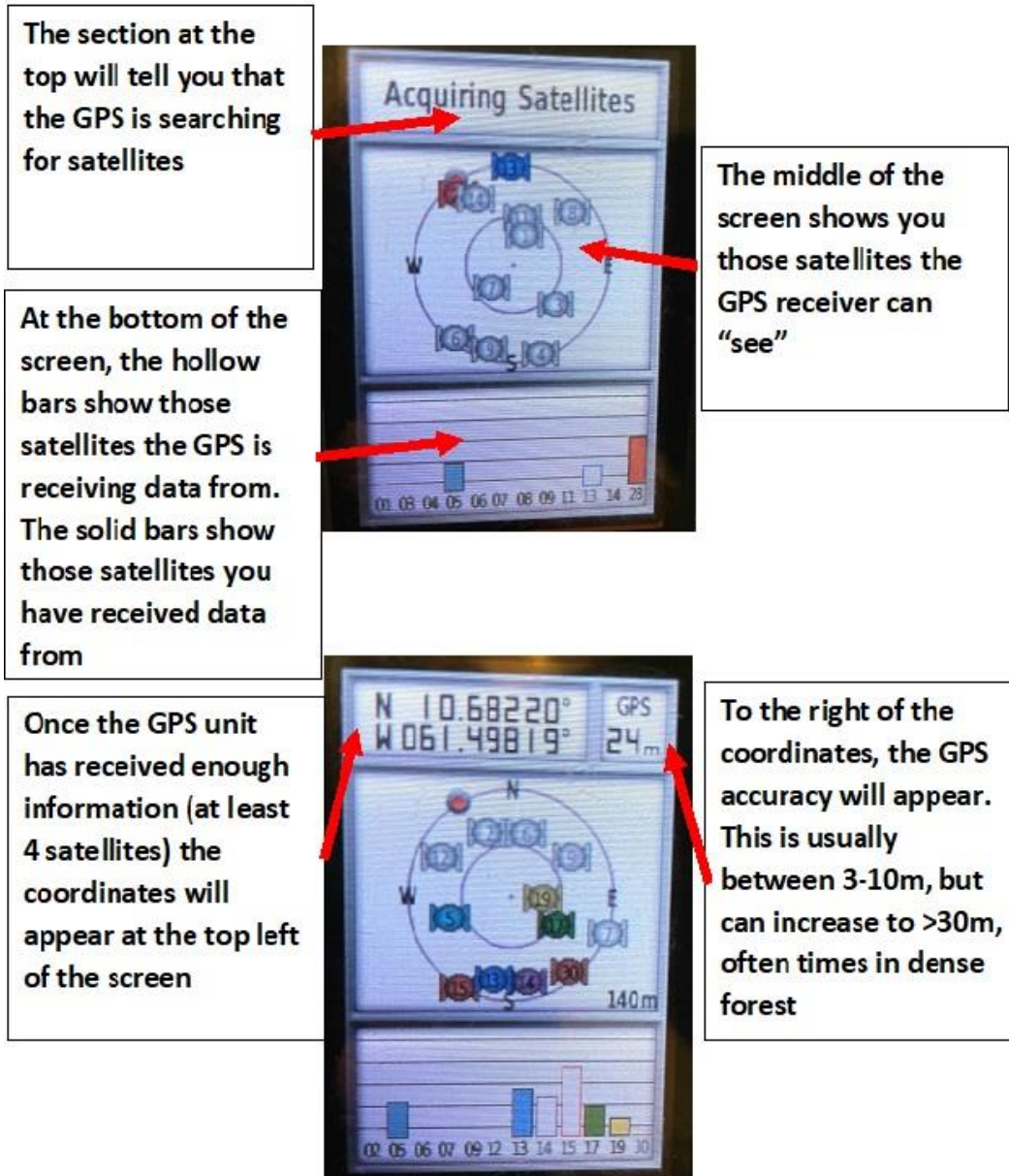


Figure 5: Checking for satellite coverage in the Garmin 62sc unit.

- e. You are now ready to mark trees or other objects on the campus. When you get to the tree or object of interest, get as close as you are able to the tree, and press the "Mark" button on the unit. Record the waypoint number, as well as the coordinates.

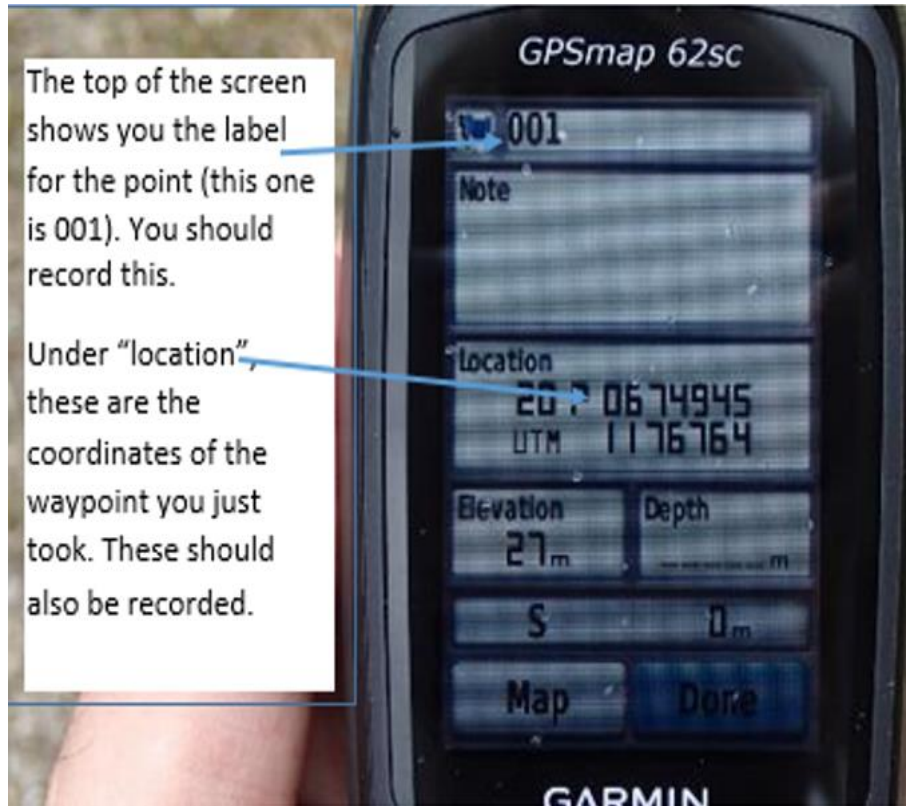


Figure 6: Marking a waypoint using the Garmin 62sc unit.

- f. In **Figure 6**, these coordinates are in UTM 20N, WGS84, so this may vary depending on your choice of coordinate system. Ensure that you save the waypoint on the GPS unit by Highlighting “Done” at the bottom of the screen, and then press Enter on the GPS unit. At this time you may also label the tree with the flagging tape and quote if you have not done so already. You can repeat steps e and f until you are satisfied that you have marked all the trees of interest.
- g. Once you have collected data from sufficient trees on campus for the students in your course, you can then download the waypoints to your Windows computer by connecting the Garmin unit to your computer via a mini-USB cable (open the rubber flap at the back next to the camera, and the socket is there). Once successfully connected, navigate to the Garmin Unit in File Explorer (Figure 7).

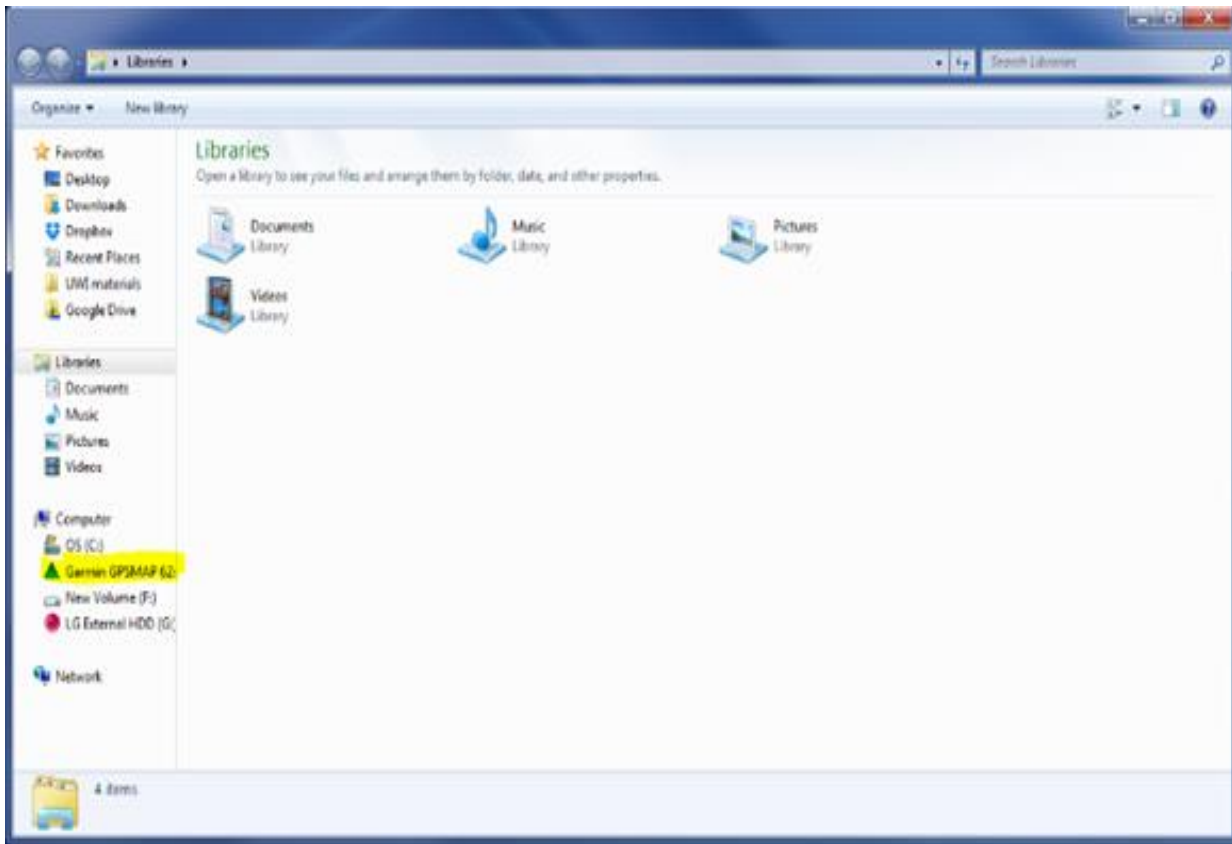


Figure 7: How the Garmin 62sc unit appears in File Explorer.

- h. Open the Garmin unit, and then open the Garmin folder. Finally, open the GPX folder, and copy the “Waypoints” file associated with the date you collected the waypoints for the trees on campus.
- i. In our highlighted example these are the waypoints associated with the 17th of May 2018 (Figure 8). Paste this GPX file into a safe location on your computer. You can now disconnect the GPS unit.

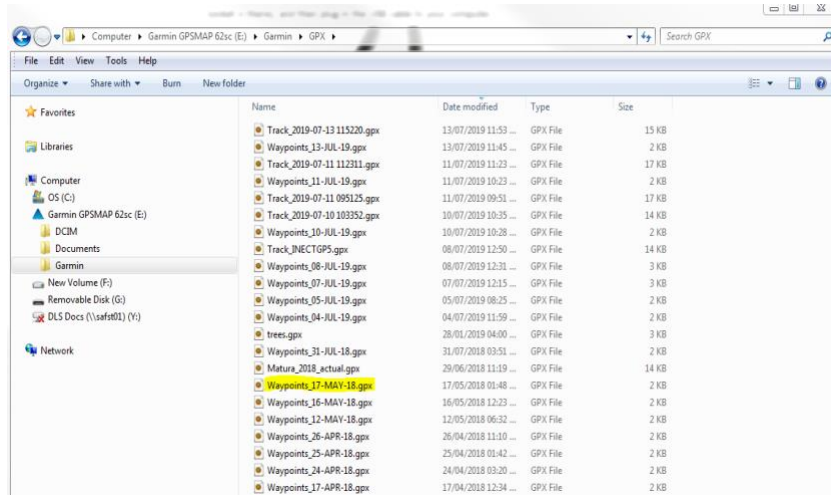


Figure 8: Navigating to the GPX file associated with the waypoints collected on campus.

Appendix C

Helpful Links:

Download QGIS software- <https://qgis.org/en/site/forusers/download.html>

GPS tutorial: Navigating to Points of Interest - <https://youtu.be/buAeJ31mTh4>

Using the Gaia app to upload GPX point files for navigation on iphone- <https://www.youtube.com/watch?v=4xAU8K9ypI8>

iNaturalist social network for naturalist- www.inaturalist.org

iNaturalist in the classroom- <https://sites.google.com/austincc.edu/inaturalistintheclassroom>

Mission, Review Process & Disclaimer

The Association for Biology Laboratory Education (ABLE) was founded in 1979 to promote information exchange among university and college educators actively concerned with teaching biology in a laboratory setting. The focus of ABLE is to improve the undergraduate biology laboratory experience by promoting the development and dissemination of interesting, innovative, and reliable laboratory exercises. For more information about ABLE, please visit <http://www.ableweb.org/>.

Advances in Biology Laboratory Education is the peer-reviewed publication of the conference of the Association for Biology Laboratory Education. Published articles and extended abstracts are evaluated and selected by a committee prior to presentation at the conference, peer-reviewed by participants at the conference, and edited by members of the ABLE Editorial Board. Published abstracts are evaluated and selected by a committee prior to presentation at the conference.

Citing This Article

Trina Halfhide, Luke Rostrant, and Georgette Briggs. 2022. Integrating GPS Technology and Gaming as Tools for Improving Spatial Intelligence. Article 7 In: Boone E and Thuecks S, eds. *Advances in biology laboratory education*. Volume 42. Publication of the 42nd Conference of the Association for Biology Laboratory Education (ABLE). <https://doi.org/10.37590/able.v42.art7>

Compilation © 2022 by the Association for Biology Laboratory Education, ISBN 1-890444-17-0. All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of the copyright owner. ABLE strongly encourages individuals to use the exercises in this volume in their teaching program. If this exercise is used solely at one's own institution with no intent for profit, it is excluded from the preceding copyright restriction, unless otherwise noted on the copyright notice of the individual chapter in this volume. Proper credit to this publication must be included in your laboratory outline for each use; a sample citation is given above.