AN INNOVATIVE PROPOSAL FOR YOUNG STUDENTS TO LEARN COMPUTER SCIENCE AND TECHNOLOGY THROUGH POKEMON GO

Ching-Yu Huang
Department of Computer Science, Kean University, Union, NJ 07083, USA
chuang@kean.edu

***Abstract* - Pokemon Go is a mobile device based game that is very popular among teenagers. The game is based on the Geographic Information System (GIS) that utilizes the player's location and interacts with many fancy characters stored in local databases, and occasionally some information stored in remote databases. The game requires a lot of computations for distances, rules, and interactions. In this paper, we propose an innovative method for young students to learn about computer science through GIS and Pokemon Go. It is very important for young students to know that computer science is not just only about coding, but also involves many other interesting topics such as security, networking, animation, modeling, graphic and interface design, databases, user experiences (UX), requirement design, technical writing, etc. The purpose of this paper is to document how to encourage young students interested in pursuing careers in computer science and technology fields.**

Keywords: *Augmented Reality, Geographic Information System, database, young students, mobile device*

1. INTRODUCTION

Code.org predicts the United States will have 1.4 million computing jobs in 2020, but colleges in the USA can only produce 400,000 Computer Science (CS) students [1]. That means there will be 1 million more jobs than students by 2020. President Obama announced "Computer Science For All" initiative program in 2016 [2] and hopes to bring more students into this field. However, there are many problems that must be fixed. A study by Stewart-Gardiner [3] showed that early exposure to educational computer games will influence middle school girls to pursue computer science in high school and college. Meanwhile, Cheryan [4] shows that stereotypes keep females out of computer science classes and STEM fields. ACM lists 4 career paths related to computer science [5] which include designing and implementing the software, devising new ways to use computers, developing effective ways to solve computing problems, planning and managing organizational technology infrastructure. It is important to let young students know that the computer related jobs are not only limited to strict implementation of computer science, but also includes other areas. Students should be encouraged to expose themselves to diverse technology fields and explore their interests.

The sophisticated Pokemon Go [6] game came out in July 6, 2016 and became very popular, especially to young teenagers. It integrates many new areas in computer technology such as a mobile device's GPS and camera, Augmented Reality, real time database interaction, computations, etc. The Pokemon that show up in 3-D and with real-time backgrounds are implemented through Augmented Reality. They utilize the geographical location to determine which Pokemon will spawn; for example, some Pokemon only show near bodies of water. The player can see, zoom in/out, and rotate the map. The PokeStops and Gyms will be only activated within a limited distance from the player. The player has gauge a 3D distance from their screen and throw the ball to catch the creature. In order to evolve a Pokemon, there are must be enough candy for that particular type. There are many other rules such as medicine to heal the wounded Pokemon, incense to lure them, etc.

This paper adopts the technology concepts and ideas used in Pokemon Go and to be incorporated in the technology curriculum for elementary and middle school computer science classes. Since the technical aspect of the game is actually quite sophisticated, this paper only discusses the aspects of the game while a player is below level 5 and cannot fight with others in gyms. The game for entry level players is simplified into four components in the proposed curriculum: Human Computer Interaction, character modeling, geographical information, and computational methods. The details of each of the components are explained in the following sections.

2. HUMAN COMPUTER INTERACTION

One of the attractive features of Pokemon Go is that it has a very good design in Human Computer Interaction (HCI) that includes user interface design, software (creatures) behaviors, Augmented Reality, character modeling, interaction between player and Pokemon, and interaction between player and the local environment.

2.1 Concepts for Teaching

Teachers can introduce the basic and simple concepts of HCI and ask students how the players interact with the creatures. There are several user interfaces and behaviors that can be observed from the game; for instance, the user

978-1-5090-5510-4/16 $31.00 © 2016 IEEE
DOI 10.1109/CSCI.2016.54

can throw regular balls to hit a creature that has a lower CP value; feed the creatures razz berries and then throw great balls; or the creature can break free and jump out of the balls. The students can be separated into two groups: a creature and a player. These two groups can interact with each other through different ways following the interactions in the Pokemon Go. Students can rotate to join different groups.

The creature group will tell the player group when and where they prefer to spawn, how they prefer to be caught, in what condition they can break free, if they require razz berries to be caught, how the character CP values should impact the catch, etc. The creature group is responsible for telling the player group information about themselves such as their CP value, a message indicating they got caught (such as Gotcha), and making a sound when they show up and disappear when the time run out.

2.2 Technology for Teaching

The teacher can explain what technology might be involved in user interfaces and behaviors for Pokemon Go. For instance, the teacher can explain inputs such as touchscreen, camera, and sound, or outputs such as special effects, Augmented Reality, options such as AR on/off, street view, player's bag, etc. The Augmented Reality output that can be explained is shown in Figure 1, where a character shows up in a real background and a regular ball is ready to be thrown. The teacher can also explain what information should be displayed so the player will be interested in catching the creature, and what information could be changed and/or saved if a creature is caught or not.

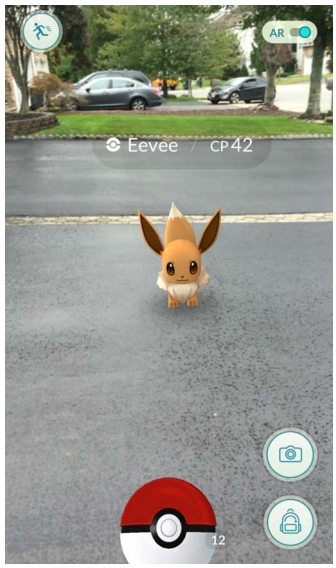

Figure 1. An Augmented Reality creature spawns for the user to catch using the ball.

3. CHARACTERS MODELING

Another attractive feature of Pokemon Go is the character modeling. It is not only designed in 3-D and animated, but it also assigns level and types for the creature. Some Pokemon have different types, while others have various forms of evolutions. For instance, a common Pidgey will evolve into a rarer form in Pidgeotto, then to Pidgeot, as shown in Figures 2a.

3.1 Concepts for Teaching

Teachers can ask students to write down what they like about the characters and which information is helpful to recognize the characters. The written information is classified into two types: category and the details. The category includes the type and name of the characters. For each type, students can define 1 to 3 levels for evolution. The details include the color, shape, animation, preferred geographical location, and the range of CP values. Figure 2b describes the details of Pidgeot which is a normal flying type.

Figure 2a. Pidgey is the most basic and first evolution in the Pidgey family. The Pidgeotto is an evolved Pidgey, and is rarer to encounter in the game without evolutions. The Pidget is the third and final evolution of the Pidgey.

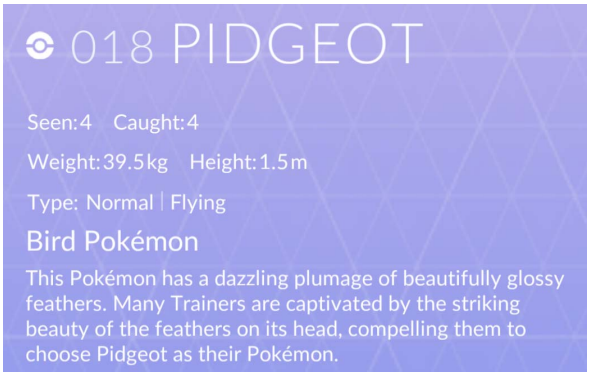

Figure 2b. The detail description of Pidgeot.

3.2 Technology for Teaching

The teacher can explain what is involved in the animation, 3-D modeling, and how is the character designed. Although it could be too early for young students to physically use Maya or other animation tools to design the character, it might be helpful to demonstrate

how by using Microsoft Paint to draw simple graphical representations of the creatures and highlight different features including colors or shapes such as the head, wing, eye, legs, or the background. In addition to character design, it could be also helpful to teach some computer graphic concepts such as rotation (view character in different angles), translation (character can jump) and scaling (zoom in/out). Students can try to do some hands-on design using Paint. For more advanced students, perhaps those in the later years of middle school, teachers could move on to Adobe Flash to teach children how to fully animate their creations.

4. GEOGRAPHICAL INFORMATION

Geographical information is the key component in Pokemon Go. It accesses the GPS data in real time on the mobile device and uses the data to display the user's standing location, specific creatures, and PokeStops and Gyms. Figure 3a demonstrates a street map with the player, stops, and gym shown in the background when the app is launched. The map will be automatically adjusted to player's latest position if the player moves.

4.1 Concepts for Teaching

The teacher can explain to student the GPS data – latitude, longitude, altitude, and direction. Photos both in-app and outside of the app embedded with GPS data when mobile device location services are turned on is called geotagged images. These types of images could reveal personal information and cause concerns with security and privacy when the young students share the geotagged images on Internet or mail them to other people. It is important that the technology curriculum should include topics about Internet security and privacy. For example, people can know where and when the photos were taken and learn more about the students' schedule and friends when enough geotagged pictures are collected.

There are several online map applications such as Google Maps and Apple Maps on mobile devices that displays the current location on the map. Using these third-party apps can be used to also supplement the students' learning about GPS. Additionally, including lessons on map direction and compass orientation may be useful. It is helpful for students to learn orientation concepts and know how to read the map to identify stops and gym locations on the Pokemon Go interface. Teachers can utilize Google Map and MS-Bing on browser to guide students on how to find the path and travel distance and time between two locations using the direction function as shown in Figure 3b. The street view function can also help enhance geographic concepts.

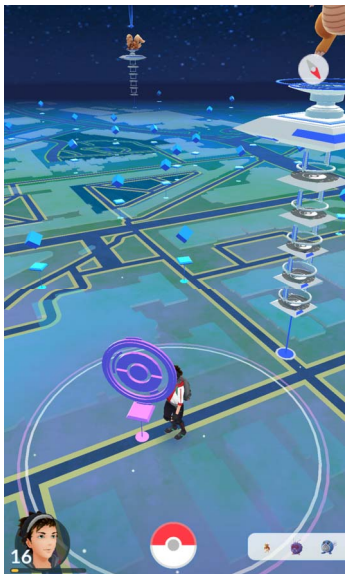

Figure 3a. The street map with the player, Stop and gym.

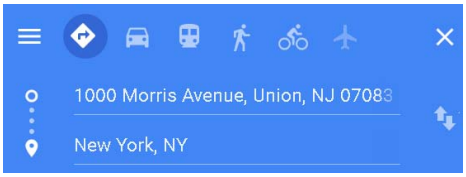

Figure 3b. The Direction function on Google Map can show the distance between two locations, and the traveling time with different methods.

4.2 Technology for Teaching

There are some software tools that can show the geotagged images and display information. IrfanView is a tool that can an extract Exchangeable image file (Exif) format that contains information such as camera setting used when taking a photographs and date and location when the pictures were taken. Figure 3c is a photo in Kean University using a mobile phone, while 3d and 3e show the image property and the Exif information extracted by the IrfanView tool. Figure 3f shows the precise location of this image indicated on Google Maps by clicking on the "Show in Google Maps" button in Figure 3e. An experienced software developer can easily write a short program to call the Google Maps API to display the location and the image facing direction as shown in Figure 3g.

It is important for young students to know security and privacy concerns on the technology that they are using every day. Location services on mobile phones is widely used in many mobile apps such as Facebook, Instagram, Google search, Weather, etc. Students should know the impact of the location service.

Figure 3c. An image taken at Kean University by a mobile device.

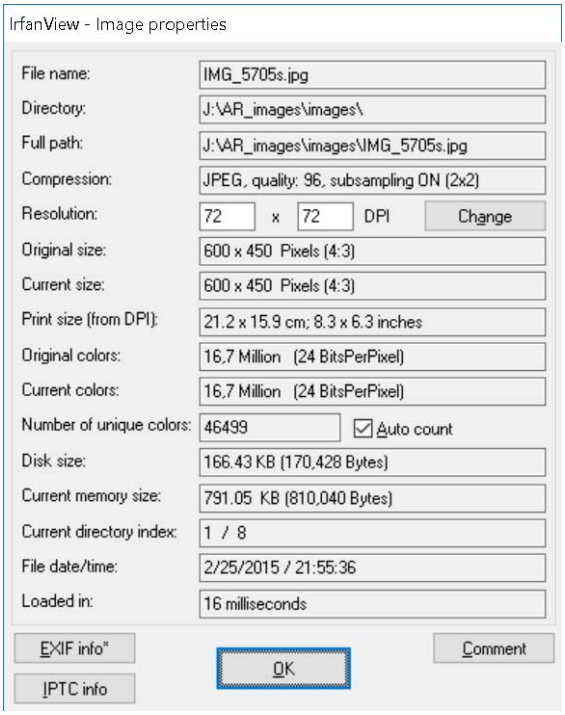

Figure 3d. The image properties of Figure 3c extracted by IrfanView.

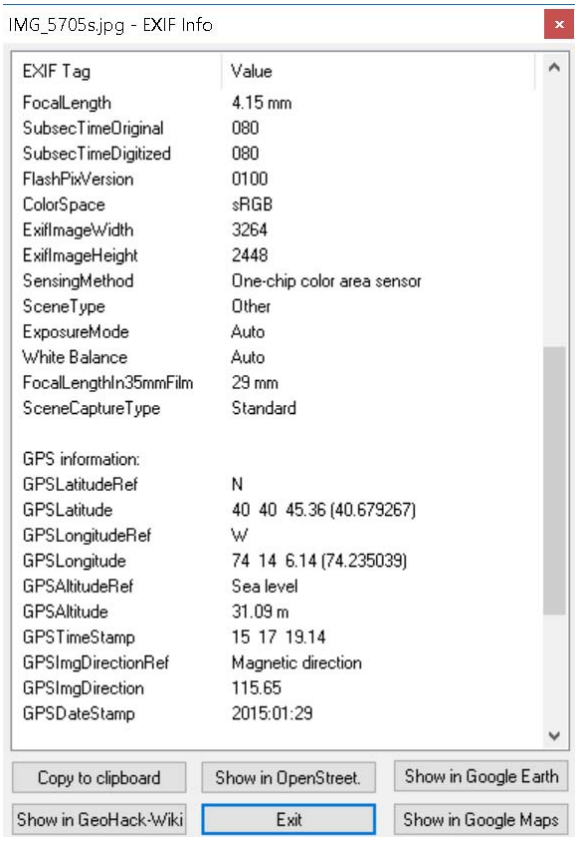

Figure 3e. The Exif data of Figure 3c extracted by IrfanView.

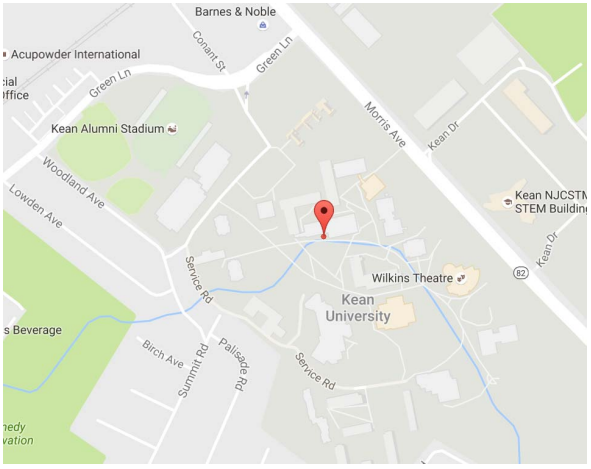

Figure 3f. The location of Figure 3c shown on Google maps from the information obtained from IrfanView.

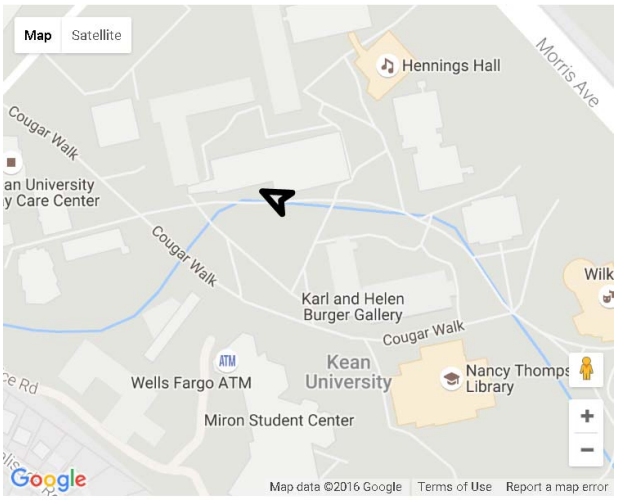

Figure 3g. The facing direction of Figure 3c can be extracted and displayed by calling Google Maps API.

5. COMPUTATIONAL METHODS

Pokemon Go requires a lot of computations in order for the user to use geographic relationships and interact between with the creatures, stops, and gyms. Understanding these computations will enhance students' math knowledge and help them understand the importance of the role of math in computer science.

5.1 Concepts for Teaching

A stop will not be enabled until the player is within the "action circle", which has a radius of 40 meters. Figure 4a shows a white circle that is centered around the user. It is easy for see if the creatures, stop, and/or gyms are inside the action circle or not. Teachers can demonstrate how the radius affects the circle size and how the stop will become available when the white circle reaches the stop and/or gym. Another use of computation is when catching a creature. The teacher can also show how creatures are caught using the two circles provided in-app. Figure 4b shows the two circles which are used to identify the hit and miss areas on Rattata.

Students can also learn how to control their throwing force and predict if the ball can hit the character when they throw a ball. The characters might jump or move when the balls are thrown on them. It can be difficult to dynamically determine if the ball hits the character. Students can be split into two groups where one is the players while the other holds a basket as the creatures. The students holding baskets could move randomly in a small range and let the players throw soft objects into different sizes of baskets. Teachers can ask students to estimate the distance and count the numbers of hits and miss for each size of baskets.

Figure 4a. A PokeStop is activated when the player is within the action circle, a radius of 40 meters.

Figure 4b. This picture illustrates where to hit a character. Two circles are used to identify the best hit and miss area.

5.2 Technology for Teaching

There are several math concepts and functions used for the computations, such as random, distance, drawing circles, etc. Teacher can use a Random Pokémon Generator [8] to explain what a random function and why it is important to show different types of characters randomly. The Distance Formula web page [9] developed by Interactive Mathematics provides a graphical plot that users can use to see the closest distance between two changeable coordinates, as shown in Figure 5a. Radius Around Point Map web page [10] developed by Free Map Tools can let students draw circles on a map on a browser and teachers can ask students which states, cities are covered in the circles by zooming in and out the map, as shown in Figure 5b.

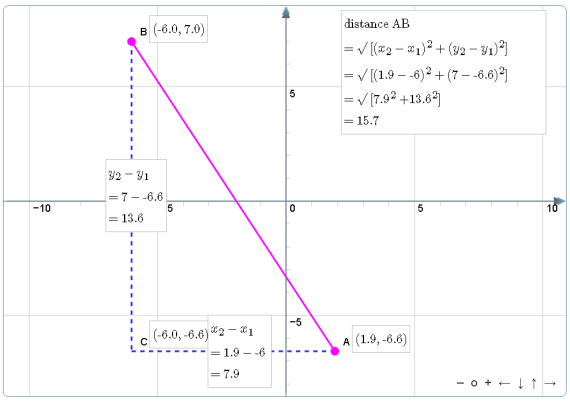

Figure 5a. The distance and coordinates are dynamically display on the plot when the two points are moved.

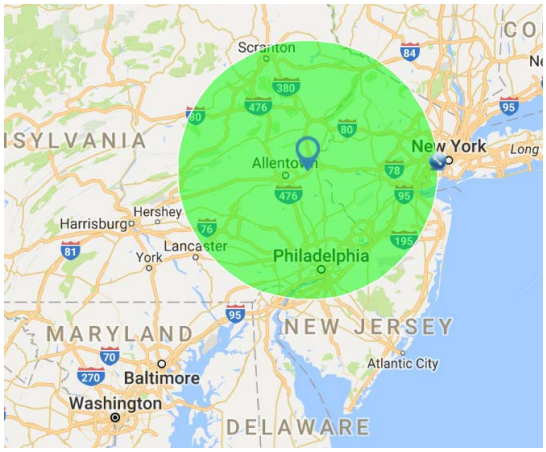

Figure 5b. The green area indicate the circle covering area.

6. CONCLUSIONS

Although students playing games on mobile devices might not be very welcome in some schools and teachers, it might be helpful to utilize a popular game such as Pokemon Go for teaching purposes and develop a curriculum to guide students for learning some useful technology and math knowledge. This paper proposes 4 components to trigger a student's interests in studying computer science and technology by utilizing the app Pokemon Go. It is very important to let young students know that there are many areas involved with computer science and technology. Pursuing a computer related career will not only relatively easy to find a job, but also fun. However, it is critical to change young students' impressions when they are young. Several activities are proposed in this paper that will let students simulate the game's design. It will be more effective to teach programming language once students show the interest in learning computer science.

7. REFERENCES

[1] Code.org, 2013. Available: https://code.org/files/Code.orgOverview.pdf

[2] Megan Smith, "Computer Science For All", *White House*, 2016. Available: https://www.whitehouse.gov/blog/2016/01/30/computer-science-all

[3] Stewart-Gardiner, C., Carmichael, G., Latham, J., Lozano, N., Greene, J., "Influencing Middle School Girls to Study Computer Science Through Educational Computer Games", *Journal of Computing Sciences in Colleges*, pp 90-97, Vol 28, June 2013.

[4] Sapna Cheryan, Allison Master, and Andrew N. Meltzoff "Cultural stereotypes as gatekeepers: increasing girls' interest in computer science and engineering by diversifying stereotypes." *Front Psychol*, 6: 49, 2015.

[5] Career in Computer Science, ACM. Available: http://computingcareers.acm.org/?page_id=8

[6] "Pokemon Go". *Wikipedia*. Available: https://en.wikipedia.org/wiki/Pok%C3%A9mon_Go

[7] Irfanview software. Available: http://www.irfanview.com/

[8] Random Pokémon Generator. Available: https://randompokemon.com/

[9] "Distance Formula", *Interactive Mathematics*. Available: http://www.intmath.com/plane-analytic-geometry/1-distance-formula.php

[10] "Radius Around Point Map", *Free Map Tools*. Available: https://www.freemaptools.com/radius-around-point.htm