Lesson Outline for ALEX

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| **General Lesson Information** |
| **Title:** Programming Tello Drone 3/3 |
| **Overview/Annotation:** Students will write scripts using the coding langue Python in the launcher Visual Studio Code to send movement commands to the Tello drone. Unlike Scratch, Python requires the user to type out lines of commands rather than dragging and dropping prewritten code blocks. Students will start by writing a script to that allows for manual control of the Tello using keyboard inputs. Then they will write a script that will command to do different movements based on the location of a colored object in orientation to the center of the screen.  **Setting:** This lesson should be taught indoors in a spacious room with access to computers or laptops that have Wi-Fi connection capabilities and internet access.  **Intended group size:** Students will need to be equally separated into groups based on the number of available Tello drones. |
| I**ntended grade level(s):** 9-12 |
| **Approximate Time of Lesson:**  Tello Movement with Keyboard Inputs 50 minutes  Tello Color tracking 50 minutes  Total time of 1 hour and 40 minutes |

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| **Researcher Biography** |
| **Name & Professional Title:** Matthew See Student Researcher, Casey Calamaio Research Engineer  **Affiliation:** Rotorcraft Systems Engineering and Simulation Center (RSESC) at University of Alabama in Huntsville (UAH)  **Contact Information:** [mss0045@uah.edu](mailto:mss0045@uah.edua) and [clc0941@uah.edu](mailto:clc0941@uah.edu)  **Brief Description of Research Interests:** The goal of our research is to determine how drones and other advanced technologies could be incorporated into an educational environment to assist with students developing their computer literacy skills. |

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| **Associated Standards and Objectives** |
| **Content Standards**: Digital Literacy and Computer Science DLIT (2018) Grade:9-12  **Computational Thinker**  **Abstraction**  2. Explain how computing systems are often integrated with other systems and embedded in ways that may not be apparent to the user.  **Algorithms**  3. Differentiate between a generalized expression of an algorithm in pseudocode and its concrete implementation in a programming language.  b. Compare and contrast the difference between specific control structures such as sequential statements, conditional, iteration, and explain the benefits and drawbacks of choices made.  c. Distinguish when a problem solution requires decisions to be made among alternatives, such as selection constructs, or when a solution needs to be iteratively processed to arrive at a result, such as iterative “loop” constructs or recursion.  **Programming and Development**  5. Design and iteratively develop computational artifacts for practical intent, personal expression, or to address a societal issue by using current events.  6. Decompose problems into smaller components through systematic analysis, using constructs such as procedures, modules, and/or objects, with parameters, and which return a result.  8. Demonstrate code reuse by creating programming solutions using libraries and Application Programming Interfaces.  9. Demonstrate the ability to verify the correctness of a program.  a. Develop and use a series of test cases to verify that a program performs according to its design specifications  b. Collaborate in a code review process to identify correctness, efficiency, scalability and readability of program code  10. Resolve or debug errors encountered during testing using iterative design process. Examples: Test for infinite loops, check for bad input, check edge-cases.  **Impact of Computing**  21. Explain how technology facilitates the disruption of traditional institutions and services.  22. Research the impact of computing technology on possible career pathways  23. Debate the positive and negative effects of computing innovations in personal, ethical, social, economic, and cultural spheres.  **Global Collaborator**  **Digital Tools**  25. Utilize a variety of digital tools to create digital artifacts across content areas.  Social Interactions  27. Apply tools and methods for collaboration on a project to increase connectivity among people in different cultures and career fields.  **Innovative Designer**  **Design Thinking**  40. Use an iterative design process, including learning from mistakes, to gain a better understanding of a problem domain. |
| **Primary Learning Objectives:**   1. Students will be able to control the Tello drone with keyboard inputs using a script they have written 2. Students will be able to have the Tello track a colored object and preform different movements based on the location of the object in relation to the center of the screen. |
| **Additional Learning Objectives:**   1. Students will learn about how drones are used in the modern world 2. Students will learn about the field of aerospace and a brief history of it 3. Students will learn about proper drone safety and regulations |

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| **Preparation Information** |
| **Total Duration:** If this lesson is being taught in order with the other related lessons then no additional software is required. Otherwise, the length of lesson preparation will be affected by the number of computers or laptops that need to have the software download and the internet download speed. A good assumption of time is roughly 10 minutes with the ability to work on multiple different devices simultaneously. The batteries should be fully charged before the start of the lesson. |
| **Materials and Resources:**   * Computers or laptops that have Wi-Fi connection capabilities and internet access * Visual Studio Code launcher with Python * Tello EDU drones   Optional   * Extra batteries * Battery charging station * Proper battery storage items |
| **Technology Resources Needed:**  [Visual Studio Code Download](https://code.visualstudio.com/)  [Python Download](https://www.python.org/downloads/)  [Tello Keyboard Input Code Example](https://github.com/damiafuentes/DJITelloPy/blob/master/examples/manual-control-opencv.py)  [Color Tracking Tutorial](https://www.youtube.com/watch?v=vDOkUHNdmKs)  [Tello Color Tracking Code Example](https://www.computervision.zone/topic/complete-code-2/) |
| **Background and Preparation:**  Before the start of the lesson the computers or laptops being used need to have Visual Studio Code and Python already downloaded. The Tello drone batteries need to have already been charged. The teacher should have working versions of the scripts that are being taught and have personally tested them out to understand what they are supposed to do. |

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| **Procedures and Activities** |
| ***Engagement:*** The teacher will start by talking about what open cv is and how it will be used to crate more advanced commands  ***Main activity:*** The students will first work with the script that reads keyboard inputs as movement commands. Next they will work with the color tracking script to send commands based on visual ques.  ***Wrap up and Reflection:*** The teacher will make sure that each group has working versions of the scripts they have worked on and answer any questions they may have.  ***Final product/Summative evaluation:*** The students now have learned basic and advanced commands for the Tello that can be used to navigate an obstacle course. |