Bio-Design Fabrication and Soft/DIY Drones

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Abstract

Bio-Design Fabrication and Soft/DIY Drones is a unit designed to introduce middle school students to using mycelium and other soft/DIY materials with drones. This unit was designed for a course in an urban, public middle school for students in grades 6th, 7th, and 8th grade (s). The unit will be using elements of CAD (Computer Aided Design), CNC (Computer Numerical Control), coding (Blockly, Python, et al), 3D printers, drones (CoDrone EDU), laser cutters, and more to fabricate (and grow) a shell and body for a DIY drone and make it a functional drone they can use in the classroom. One of the main elements of the unit is focusing on critical thinking. Project fabrication may be digitally oriented, but it will not be limited to just these materials, tools, and/or media as assembly is ultimately a hands-on enterprise, working with their mind and hands to create a drone using mycelium and other soft materials. This is to meet the needs of a classroom that may feature students from a diverse array of educational, cultural, and linguistic backgrounds in a school such as ours.

Key Words

Drones, Soft drones, Mycelium, Bio-Fabrication, Digital Fabrication, Design, Bio-Design

Unit Content and Teaching Strategies

Introduction

I am an art teacher overseeing a Maker space in a public middle school, where we explore art, design, and STE(A)M topics. I have a keen interest in engaging students in the creation and use of drones, along with the associated coding and fabrication processes. Our Maker space is well-equipped with CNC machines, 3D printers, laser-cutters, and other tools, enabling us to fabricate various projects, including soft drones.

The prospect of utilizing soft drones is particularly intriguing to my students, who are eager to delve into materials exploration. This interest extends to unconventional materials like mycelium and other bio-materials, which aligns with my personal passion. I also share my expertise by teaching these concepts to adult learners at other institutions.

Many of my students are exceptionally gifted and high-achieving young individuals bound for top schools in Philadelphia. To provide them with a unique and enriching experience, I am eager to introduce the creation of soft/DIY drones in our Maker space. This opportunity is rare within the district, and I believe it aligns well with my pedagogical approach, emphasizing a holistic learning experience that engages both hands and minds.

In the previous section, I mentioned that I oversee a makerspace at the largest middle school in the city, covering art, design, and STEAM topics. I believe incorporating soft drones, mechanisms, and similar elements can enhance students' design thinking skills and bridge the gap between 21st-century and traditional skills they acquire. Currently, our makerspace utilizes servos with Arduino®, Micro:bit®, and other devices.

This addition aligns with the interests of students eager to explore materials, particularly bio-materials, and engage in DIY projects, including kits for making Micro:bit® drones. I aim to offer the unique experience of crafting these soft drones within the makerspace, extending the opportunity to any student intrigued by the creation of dynamic soft drones.

Several objectives include mastering the fabrication techniques essential for successful drone construction, especially when working with materials like mycelium and other bio-materials in tandem with coding and servos. Despite challenges, such as the large class sizes (maxing out at 33 students) and the school's 6-day rotating schedule accommodating over 1500 students, I envision addressing these hurdles to expose a significant number of students to this exciting venture throughout the school calendar's four quarters.

I anticipate that the process of designing, creating, and fabricating will vary across the sections, grades, and skill levels I instruct, reflecting diverse interests. Inspired by the structure of our drone seminar, I am keen on developing mini-skill sections that delve into aspects such as code, servos, and materials fabrication. In these sections, I encourage students to pose their own design questions, empowering them with a sense of agency over their work, as I believe this approach enhances engagement in my classes.

While students are encouraged to explore their ideas, my role involves providing insight and making final judgments on whether their designs can be fabricated within the project's parameters and with the tools available in the classroom makerspace. I aim for their creations to be simple and streamlined, employing art/design skills and basic hand-building techniques. High-tech tools are incorporated only when necessary, ensuring a successful and gratifying learning experience for the students.

Overview

Participating in this comprehensive seminar provides a profound immersion into the world of drones, unveiling a wealth of knowledge spanning historical contexts, regulatory landscapes, and practical applications. The exploration of drone history not only sheds light on their evolution but also underscores their burgeoning popularity for both commercial and recreational purposes. Understanding the diverse opportunities drones offer, from STEM education to coding applications, reveals their versatility as valuable educational tools. The seminar that I have attended introduces participants to the multifaceted role of drones in teaching subjects such as aerodynamics, flight mechanics, and programming, highlighting their potential to foster critical thinking and problem-solving skills among students.

As the seminar progressed, I gained hands-on experience through an introduction to drone kits, manual flight, and programming using Blockly and Python. This practical approach demystifies the specialized components of drones, elucidating how they collaborate to achieve controlled and purposeful flight. Delving into the intricacies of flight basics, safety measures, and the progressive transition from Blockly to Python programming offers a comprehensive skill set for effective drone operation. The inclusion of sensors and advanced programming in Python elevates participants' understanding, providing a deeper insight into the technical complexities of drone technology. Moreover, opportunities like our visit to the GRASP Lab at PERCH and guest lecturers like Justin Thomas from EXYN who are industry experts enriching mine and other participants' knowledge with real-world applications and cutting-edge advancements, which we can then extend to our student population. The seminar's holistic approach, culminating in drone demonstrations, ensures that participants not only acquire theoretical knowledge but also gain practical expertise in the diverse facets of drone technology.

Embarking on the journey of creating and flying drones made out of mycelium represents not merely an addendum but a natural continuation of the core skills acquired during the Soft Robots seminar. While the Soft Robots seminar laid the foundation for understanding flexible and adaptable robotics, the exploration into mycelium-based drones takes these principles a step further. Building on the expertise of our instructor, this new venture introduces a unique blend of ecological sustainability and innovative design to the realm of robotics with drones. The mycelium-based drones that I envision the students creating seamlessly integrate with the soft robotics principles, emphasizing adaptability and versatility. This process involves utilizing the history, skills, ideas, and concepts of drone technology that this seminar has provided me. The new knowledge of drones, coupled with groundbreaking advancements and mycelium, offers a biodegradable and environmentally friendly alternative to traditional materials. The incorporation of new skills, underscores the dynamic nature of technology and the importance of staying at the forefront of emerging trends in robotics education. As I implement these advancements in my teaching, the journey from soft robots to mycelium-based drones becomes a testament to the ongoing evolution of skills and knowledge in the field, providing students with a holistic and forward-thinking education in robotics, especially in the exciting field of drones.

While I have experience in coding and crafting in K-12 classrooms through digital and hand-building methods, delving into soft drones, particularly mycelium-based creations, is new for me. The insights gained from the compliant drone’s seminar have sparked my curiosity, and I see ample learning opportunities for students as we explore the effective integration of soft materials in our projects.

Students will work with various micro boards and servos, primarily utilizing the Hummingbird® kit from BirdBrain Technologies, which employs the Micro:bit® as the core component. This serves as a foundational tool for understanding basic coding and the mechanics of motors/servos. Most students will engage in block coding through MakeCode or Blockly on the RoboLink website, while advanced students will experiment with Java, Python, and other languages for their drone projects.

In this hands-on project, students will use MakeCode/Blockly and the Micro:bit to create soft drones. The unique aspect involves fabricating these drones using mycelium-based materials for the body and/or structure. By growing mycelium kits from Ecovative, students will craft molds, apply design thinking, and utilize 3D printing, laser cutting, or CNC techniques to shape their drone structures. While mycelium is a key material, students have the flexibility to use alternative materials like popsicle sticks and craft materials if they choose not to incorporate mycelia.

Rationale

Within my art and STE(A)M class, I aim to inspire a sense of wonder, creativity, investigation, and curiosity among my students. Unlike the conventional approaches they encounter in other educational domains, I encourage them to view problems through a different lens. My role is to cultivate thinking that involves both their hands and minds concurrently. The true skill lies in the process of learning, whether it's through the exploration of soft drones or other means.

"The one really competitive skill is the skill of being able to learn. We need to produce people who know how to act when they're faced with situations for which they were not specifically prepared." -Seymour Papert

Employing a combination of traditional hand-building skills and cutting-edge 21st-century tools like laser-cutters, 3D printers, micro-controllers, and motors, we guide our students in developing an appreciation for using both timeless craftsmanship and contemporary technologies. This approach encourages them to engage their minds in conjunction with new and emerging technologies, preparing them for potential job requirements that may not currently exist but could emerge in the future.
By centering a project around soft drones, we aim to shift the perspective from the ubiquitous hard metallic drones seen on television. This deliberate choice fosters a constructive learning environment, nurturing a growth mindset that values exploration and continuous learning while engaging both their mental and manual capabilities.

Objectives

I envision that a central objective should be the simultaneous engagement of both the mind and hands, leveraging a combination of traditional and modern tools and expertise. Ideally, the process of working with soft drones would facilitate the development of skills and problem-solving abilities. Whether utilizing DIY components or exploring bio-materials like mycelium, individuals should cultivate an understanding of material science's inherent nature and the hands-on craftsmanship required to seamlessly integrate code with drones.

Projects like soft drones demand self-directed learning, inventive problem-solving, and a robust work ethic, pushing individuals to think unconventionally and surpass standard solutions. Tackling such projects serves as a meaningful measure of success, fostering the acquisition of skills, strategic planning, and precision in measurements using tools such as calipers, t-squares, and protractors. These tangible objectives are achieved through experiential learning, with the acquired skills extending beyond the academic setting to become lifelong assets applicable in various real-world scenarios.

"The principal goal of education in the schools should be creating men and women who are capable of doing new things, not simply repeating what other generations have done-"Piaget, J.

The ultimate goal is to nurture self-advocacy and self-realization in students through their active participation in the work. While these aspects are not typically assessed or highlighted in contemporary classrooms, they carry substantial importance in the realms of work and creation, encompassing coding, fabrication, and building. This focus on personal empowerment extends beyond the classroom setting, holding relevance in the broader context of real-world applications and fostering an understanding of the processes and mechanisms involved in constructing things.The ultimate goal is to nurture self-advocacy and self-realization in students through their active participation in the work. While these aspects are not typically assessed or highlighted in contemporary classrooms, they carry substantial importance in the realms of work and creation, encompassing coding, fabrication, and building. This focus on personal empowerment extends beyond the classroom setting, holding relevance in the broader context of real-world applications and fostering an understanding of the processes and mechanisms involved in constructing things.

"I hear and I forget. I see and I remember. I do and I understand."

~ *Confucius*

Strategies

The core instructional approaches aligned with the objectives of this unit center around the utilization of open-ended questions and engaging students in hands-on activities, specifically integrating digital fabrication techniques like laser cutting and 3D printing. The focus is on fostering problem-solving skills as students navigate the intricacies of drone projects.
The initial strategy aims to ensure students possess a solid understanding of coding, acknowledging its equal significance alongside the fabrication and construction aspects of drone development. Whether employing block coding with MakeCode, Java, or Python, students are expected to comprehend how lights, servos (both positional and rotational), and other components interact with the Micro:Bit, the chosen equipment for their drones.

The second strategy involves equipping students with proficiency in utilizing digital fabrication tools and associated software, including Cura for 3D printers and Glowforge's web-based interface. Once tested and comprehended, students can apply this knowledge to execute precise fabrications.

Within the digital fabrication component, particular attention is given to the use of Ecovative's mycelium or Grow.bio's grow-it-yourself material for soft drone bodies. A specific aspect focuses on properly growing mycelium sheets with dimensions of 20"x1". MakerCase (https://www.makercase.com/#/) is recommended as a resource for creating the SVGs necessary to shape the drone bodies.

The final strategy encompasses hands-on building with materials, incorporating safety protocols for tools such as electric cutters and saws. Demonstrations on the proper use of these tools will be provided to achieve optimal results. Additionally, guidance on applying finishing touches and connecting the Hummingbird/Microbit with the servos will be included.

Classroom Activities

Overview

Intro:

Students will receive an introduction to various facets of the project, including coding, mycelium growth/fabrication, implementation, and the design process. Additionally, they will be familiarized with mycelium and the subsequent post-growth procedures. The session will involve the introduction and discussion of soft drone examples, alongside traditional ones, and will showcase previous student work as illustrative examples.

Objectives:

Students will begin to understand the basic elements of design thinking and other 21st-century skill sets via a set design challenge.

Essential Question:

How can one craft a soft drone using mycelium and other soft materials as outlined in the provided materials?

Whole Group Instruction:

Initiate the Design Thinking process and introduce maker technology, covering digital fabrication, working with bio-materials like mycelium, coding, and 3D printing/modeling using platforms such as Tinkercad and Morphi. Guide students with design cards, providing tutorials on MakeCode software. Progression will occur from block coding to Java and then to Python for advanced learners. New tutorials will be offered for beginners in coding.

Differentiation:

Students will express their designs through coding, drawing, mapping, labeling, and other avenues, utilizing Glowforge software for rendering.

Small Group Instruction:

Guide students using design cards, offering tutorials on Micro:bit software and the Hummingbird. Though the Hummingbird isn't directly for drones, it aids in understanding servos/motors, crucial for drone applications. Tip sheets, videos, and prompts will support independent project work. Relevant links, such as https://makecode.microbit.org/#editor, will guide coding, fabrication, and the use of mycelium in soft drone creation.

Introduction:

This lesson plan spans several sections, covering an eight-week project that constitutes a quarter of the school year. The initial section introduces MakeCode, JavaScript, and Python coding with the Micro:bit. The second part transfers this knowledge to work with the Hummingbird kit through code, controlling drone servo motors, lights, and basic sensors. The final phase involves cultivating mycelium for drone fabrication, employing hand tools like Worx ZipSnips to shape bio-material into drone bodies. Laser cutting and Glowforge software implementation will be demonstrated alongside the Hummingbird drone tutorial.

Student Objectives:

Completion of this lesson should equip students with understanding concepts like mycelium, block vs. Java/Python coding, utilizing servos, and engaging in digital fabrication using techniques like 3D printing and laser cutting.

Overview of Lesson Process:

As an eight-week unit, introductions and demonstrations will be staggered based on class needs. Key phases include MakeCode introduction, mycelium growth demonstration, exploration of drone project options, hands-on and digital fabrication techniques demonstration, and showcasing finished pieces through video/photos or prior student work.

Procedures:

Outlined every week for the eight-week project:

- Week 1-2: MakeCode, JavaScript, and Python coding with the Micro:bit.
- Week 3-4: Familiarity with DIY setups or Micro:bit drone kits, adding components to soft drones. Mycelium growth during this period.
- Week 5-6: Designing and fabricating using mycelium and other materials.

- Week 7-8: Finalizing soft drones, testing, reevaluating, and reprogramming.

Wrap-up Discussion:

Evaluate which drones performed well, discuss fabrication success and challenges, and assess the effective use of servos, sensors, and lights in alignment with their designs.

Materials:

- Micro:Bit
- Micro USB Cord
- AA batteries
- 1/8" baltic birch plywood for laser cutting
- Chipboard 24"x 12"
- Glowforge or any laser cutter with a work area of 20"x 12"
- 3D modeling apps (Tinkercad, Blender, Fusion360, etc.
- 3D printer and filament (http://ultimaker.com)
- Mycelium (http://grow.bio)
- Various materials for growing mycelium according to the Ecovative guide
- Hot glue guns
- Glue sticks
- Acrylic paint
- Brushes (various sizes)
- Ball bearing(s)
- Xacto blade
- Ruler
- Cutting mat
- T-square
- Worx ZipSnips
- Sharpies

Tips for Safety:

Demonstrate proper usage of Xacto blades, cutting mats, hot glue guns, ZipSnips for cardboard cutting, and explicit guidance on using the Glowforge laser cutter and its web-based software.

Resources (included in the Lesson Plan):

- https://makecode.microbit.org
- https://s3-us-west-2.amazonaws.com/ecovative-website-production/documents/Grow-It-Yourself-Instruction-Manual-v1.0.pdf

- https://www.makercase.com/#/

***Alternative Lesson(s)**

Creating a Drone Body with Origami Mycelium Using a Laser Cutter

Grade Level: Middle School

Objective:

Students will learn how to design and fabricate a drone body using origami techniques and mycelium material and utilize a laser cutter for precision cutting.

Materials:

- Mycelium material (pre-grown or ready for cultivation)
- Laser cutter
- Computer with design software (e.g., Adobe Illustrator, Inkscape)
- Origami templates or patterns
- Safety equipment (gloves, safety glasses)
- Water spray bottle
- Brushes for mycelium application
- Ruler
- Cutting mat
- Drones (for attaching the created bodies)

Duration: 2 class periods (90 minutes each)

Introduction (20 minutes):

- **Discussion:** Begin with a discussion on the importance of lightweight and eco-friendly materials in drone design. Introduce mycelium as a sustainable material.
    - **Video:** Show a brief video on mycelium and its applications in various industries.
    - Example: Mycelium: The Future of Materials

Understanding Mycelium (20 minutes):

- **Explanation:** Provide a brief explanation of mycelium and its growth process.
- **Hands-On Demo:** Show a live demonstration of mycelium material and how it can be applied to surfaces.

Origami Design (30 minutes):

- **Introduction to Origami:** Discuss the principles of origami and its application in design.
- **Template Selection:** Provide origami templates or patterns suitable for creating a drone body. Explain how to choose or design templates that align with the drone's structure.

Designing in Software (30 minutes):

- **Software Overview:** Introduce the design software (e.g., Adobe Illustrator, Inkscape) for creating origami patterns.
- **Template Creation:** Guide students through the process of transferring origami patterns onto the design software. Emphasize precision for compatibility with the laser cutter.

Laser Cutting (40 minutes):

- **Laser Cutter Safety:** Briefly cover laser cutter safety protocols.
- **Material Preparation:** Prepare the mycelium material for laser cutting.
- **Laser Cutting Process:** Demonstrate how to set up the laser cutter and execute the cutting process using the origami patterns.

Assembly (30 minutes):

- **Origami Assembly:** Instruct students on how to assemble the cut mycelium pieces using origami techniques.
- **Securing Components:** Discuss methods for securely attaching the drone components to the mycelium body.

Testing and Evaluation (20 minutes):

- **Drone Integration:** Attach the mycelium bodies to drones and test their functionality.
- **Discussion:** Lead a discussion on the performance, durability, and environmental benefits of the mycelium drone bodies.

Reflection and Future Applications (10 minutes):

- **Reflection:** Have students reflect on the challenges, successes, and the overall learning experience.
- **Future Applications:** Discuss potential applications of mycelium-based drone bodies in various industries.

Homework/Extension Activity:

Challenge students to explore other biomaterials or modify their designs for different drone types. Encourage them to research real-world applications of sustainable drone bodies.

By the end of this lesson, students will have gained hands-on experience in designing and fabricating drone bodies using origami mycelium, fostering creativity, and understanding sustainable material applications in technology.

In conclusion, DIY mycelium-made drones represent a groundbreaking fusion of sustainability and technology. By harnessing the regenerative and eco-friendly properties of mycelium, enthusiasts can craft lightweight yet robust drone bodies through accessible do-it-yourself methods. This innovative approach not only reduces the environmental impact associated with traditional drone materials but also opens avenues for creative exploration in biomaterial engineering. The mycelium's adaptability and versatility empower individuals to experiment with intricate designs, pushing the boundaries of both biological and technological realms. As we witness the rise of mycelium-made drones, we embark on a journey toward more sustainable, nature-inspired solutions in the ever-evolving landscape of DIY drone fabrication. The convergence of biology and engineering in this endeavor underscores the limitless possibilities for environmentally conscious innovations in the realm of unmanned aerial vehicles.

Title: Flight Adventures: Integrating STEM through DIY Drone Building and Aerodynamics

***Based off of the following:**

Title: CoDrone Blockly SR Flight Events

URL: [https://learn.robolink.com/lesson/codrone-blockly-sr-flight-events/]

Publisher: Robolink

Publication Date: [12/26/2023]

Grades 4-8

Overview:

Flight activities offer a dynamic educational experience for students in grades 4-8, exploring the fascinating world of drones and aerodynamics. This hands-on lesson plan combines science, technology, engineering, and mathematics (STEM) with creative arts and design, providing students with an immersive understanding of drone flight principles. The lesson includes key questions, educational goals, materials, and aligns with various educational standards.

Key Questions:

- How do drones achieve flight, and what principles govern their aerodynamics?
- How can students apply STEM concepts to design, build, and fly their DIY drones?

Educational Goals:

By the end of the lesson, students will be able to:

- Explain the principles of drone flight, including takeoff, hovering, and landing.
- Develop and implement a Blockly program for drone takeoff, hovering, and landing.
- Design and execute a Blockly program for the drone to perform specific tasks, such as pushups, within a given time limit.
- Engineer a solution to lift the largest possible payload.
- Gain insight into the fundamentals of drone technology and aerodynamics through the DIY drone building session.
- Assemble a DIY drone from scratch, understanding the importance of different components and their functions.
- Apply mathematical calculations to determine the speed, altitude, and flight time of their DIY drones based on the components used.

Equipment and Supplies Needed for the Lesson:

- CoDrone EDUs drones with batteries (distributed as 2 drones for every table of ten)
- Whiteboard setup for presenting online videos with sound and shared screens.
- Laptops or desktop computers with internet access or WiFi.
- Engineering journal (or worksheets for documentation and reflection).
- DIY Drone Video for instructional purposes.
- Drone building kits (or individual components like motors, propellers, frames, flight controller, battery, etc.). Micro:bit DIY drone kits are one example.
- Tools essential for drone assembly, including screwdrivers and pliers.
- Safety equipment, such as safety goggles and gloves, as well as drone net for the flying area.
- Optional sketchbooks and art supplies for creative expression and design aspects of the lesson.

Educational Standards:

Common Core State Standards (CCSS):

- ELA-LITERACY.RI.4.7: Interpret information presented visually, orally, or quantitatively and explain how it contributes to an understanding of the text.
- ELA-LITERACY.RI.5.7: Draw on information from multiple print or digital sources to locate answers or solve problems efficiently.
- ELA-LITERACY.RI.6.7: Integrate information presented in different media or formats to develop a coherent understanding of a topic.
- ELA-LITERACY.RST.6-8.3: Follow a multistep procedure when carrying out experiments or technical tasks.
- ELA-LITERACY.RST.6-8.7: Integrate quantitative or technical information expressed in words with a visual representation.
- ELA-LITERACY.RST.6-8.9: Compare and contrast information gained from different sources on the same topic.
- MATH.PRACTICE.MP5: Use appropriate tools strategically.
- MATH.PRACTICE.MP7: Look for and make use of structure.

Next Generation Science Standards (NGSS):

- 3-5-ETS1-1: Define a simple design problem with specified criteria for success and constraints.
- MS-ETS1-1: Define design problem criteria and constraints with precision, considering relevant scientific principles and potential impacts on people and the environment.

Computer Science Teachers Association (CSTA):

- 1B-CS-03: Determine potential solutions to solve simple hardware and software problems.
- 1B-AP-15: Test and debug a program to ensure it runs as intended.
- 1B-AP-17: Describe choices made during program development.
- 2-CS-03: Systematically identify and fix problems with computing devices.

International Society for Technology in Education (ISTE):

- 5D: Students understand automation and use algorithmic thinking to develop a sequence of steps for automated solutions.
- 6A: Students choose appropriate platforms and tools to meet their creation or communication objectives.

Lesson Plan:

Session 1: Introduction to Drones and Aerodynamics

Begin by introducing students to the world of drones and the basic principles of aerodynamics. Show the DIY Drone Video to provide a visual understanding of drone components and their functions.

Engage in a discussion about key concepts, including lift, thrust, drag, and gravity, as well as the importance of trim, yaw, and the X, Y, and Z axes. Additional research can be to assign a research project for students to explore real-world applications of drones, such as aerial photography, search and rescue, and delivery services.

Session 2: Understanding Drone Components

Review the key components highlighted in the DIY Drone Video, including motors, propellers, frames, flight controllers, and batteries. Discuss the function of each component and how they collaborate to facilitate drone flight. Showcase different types of drone kits or individual components available for assembly.

Session 3: DIY Drone Assembly

Provide students with drone-building kits or individual components, ensuring each group has the necessary tools for assembly. Guide students through the step-by-step assembly process, emphasizing the function of each part. Emphasize safety precautions and responsible tool handling. Encourage students to document their assembly process through writing or sketches in their engineering journals.

Session 4: Testing and Flying the DIY Drones

Allow students to test their assembled drones in a controlled environment. Discuss calibration and troubleshooting methods for any drone issues. Encourage students to experiment with the drones' flight and maneuverability. Conclude the lesson with a discussion on the challenges and successes encountered during the DIY drone building and flying experience.

Extension Activities (Arts and Mathematics):

Students can create artwork or diagrams illustrating principles of aerodynamics and the mechanics of drone flight. Utilize mathematical calculations to determine the drone's speed, altitude, and flight time based on the components used.Have students design and decorate their drone frames, merging artistic creativity with engineering.

Assessment:

Assess students' comprehension of drone technology, aerodynamics, and their ability to assemble and fly a DIY drone.Evaluate reports and presentations on the history and types of drones, assessing research and communication skills.

This comprehensive STEM lesson seamlessly integrates science, technology, engineering, and mathematics, providing students with a real-world application of technology and fostering creativity in aerodynamics and drone construction.

Title: Exploring Flight Movements with CoDrone EDUs

***Based off of the following:**

Title: Exploring Flight Movements with CoDrone EDUs

URL: [https://learn.robolink.com/lesson/codrone-python-flight-movements/]

Publisher: Robolink

Publication Date: [12/26/2023]

Grades 4-8

Summary:

In this engaging lesson, students will delve into the world of flight movements using CoDrone EDUs. Through hands-on exploration, students will gain a comprehensive understanding of how drones maneuver in the air. The lesson focuses on guiding questions that encourage critical thinking and problem-solving, promoting a deeper appreciation for the principles of flight.

Guiding Question(s):

- How do drones execute various flight movements, and what principles govern their actions?

Learning Objectives:

By the end of the lesson, students will be able to:

- Identify and explain common flight movements performed by drones.
- Demonstrate the ability to program CoDrone EDUs to execute specific flight maneuvers.
- Analyze the principles of aerodynamics and navigation as they relate to drone flight.
- Collaborate with peers to problem-solve and troubleshoot during flight activities.

Equipment and Supplies Needed for the Lesson:

- CoDrone EDUs drones with batteries (distributed as 2 drones for every table of ten)
- Technology setup for presenting online videos with sound and shared screens.
- Laptops or desktop computers with internet access.

Optional Materials:

- Visual aids (charts, diagrams) illustrating flight movements and principles.
- Additional programming tools or software for advanced exploration.
- Whiteboard and markers for collaborative discussions and problem-solving.
- Safety cones or markers to create a designated flying area.

Educational Standards:

Common Core State Standards (CCSS):

- ELA-LITERACY.RI.4.7: Interpret information presented visually, orally, or quantitatively and explain how it contributes to an understanding of the text.
- ELA-LITERACY.RI.5.7: Draw on information from multiple print or digital sources to locate answers or solve problems efficiently.
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International Society for Technology in Education (ISTE):

- 5D: Students understand automation and use algorithmic thinking to develop a sequence of steps for automated solutions.
- 6A: Students choose appropriate platforms and tools to meet their creation or communication objectives.

Lesson Plan:

Introduction (15 minutes):

- Begin with a brief discussion about the principles of flight, introducing key concepts like lift, thrust, drag, and gravity.
- Pose the guiding question: "How do drones execute various flight movements, and what principles govern their actions?"
- Show a brief video showcasing different flight movements of drones to spark curiosity and interest.

Exploration of Flight Movements (30 minutes):

- Distribute CoDrone EDUs to students, ensuring they have access to laptops or desktop computers.
- Provide a hands-on demonstration of basic flight movements using a CoDrone EDU, emphasizing takeoff, hovering, forward/backward movement, and turning.
- Allow students to experiment with the drones, taking turns to practice and observe different flight movements.

Programming Challenge (45 minutes):

- Introduce basic programming concepts for CoDrone EDUs, emphasizing the use of Blockly programming language.
- Assign a programming challenge where students must code the drones to perform specific flight movements, such as a figure-eight pattern or a controlled landing.
- Encourage collaboration and problem-solving among students as they work on the programming challenge.
- Provide support and guidance as needed, fostering a collaborative and inclusive learning environment.

Analysis and Reflection (15 minutes):

- Gather students for a group discussion to share their experiences and observations during the programming challenge.
- Discuss the principles of aerodynamics and navigation as they relate to the executed flight movements.

- Reflect on challenges faced and problem-solving strategies employed during the programming activity.

Optional Extension Activities (30 minutes):

- Explore advanced flight movements and programming options for CoDrone EDUs.
- Conduct a group challenge where students design and execute a coordinated drone dance or flight routine.
- Integrate optional materials like visual aids, whiteboards, or safety markers for enhanced exploration.

Conclusion and Assessment (15 minutes):

- Conclude the lesson by revisiting the guiding question and summarizing key learnings.
- Assess students based on their participation in the programming challenge, group discussions, and reflections.
- Encourage students to share their insights and newfound knowledge with the class.

This lesson provides an immersive experience for students to explore flight movements, combining hands-on activities with programming challenges. Through this interactive approach, students develop a deeper understanding of aerodynamics and navigation while enhancing their problem-solving and collaboration skills.

Lesson Title: Remote CoDrone Drone Operation using Blockly

Grades: 4-8

Key Questions:

- How can we use Blockly programming to remotely operate CoDrone drones?
- What are the key components and commands needed for successful drone navigation?

Educational Goals:

By the end of the lesson, students will be able to:

- Program CoDrone EDUs using Blockly for remote drone operation.

- Navigate drones through a predefined obstacle course using Blockly commands.
- Demonstrate understanding of programming concepts, including loops and conditional statements.
- Collaborate with peers to troubleshoot and optimize drone navigation programs.

Materials:

- CoDrone EDUs drones with batteries (distributed as 2 drones for every table of ten).
- Technology setup for presenting online videos with sound and shared screens.
- Laptops or desktop computers with WiFi access.
- Engineering journal or worksheets (for documenting and reflecting on programming activities).
- Materials to set up an obstacle course (PVC pipes, stacked chairs, desks, etc.).

Optional Materials:

- Landing pads (colored paper, poster-board, cardboard, taped-off floor section, books, or boxes, etc.).
- Colored construction paper for additional coding challenges.
- Materials for creating hoops.).

Lesson Plan:

Engagement (Introduction) - 15 minutes:

- Begin with a brief discussion about the concept of remote drone operation.
- Pose the key questions to the students.
- Introduce Blockly programming as a tool for remotely controlling CoDrone drones.
- Show a short video demonstration of a CoDrone navigating through an obstacle course using Blockly commands.

Exploration (Activity) - 45 minutes:

- Divide students into groups, ensuring each table has two CoDrone drones.
- Distribute laptops or desktop computers to each group.
- Instruct students to access Blockly programming and guide them through the basics of block-based coding for drone navigation.
- Set up an obstacle course using materials provided.

- Allow students to experiment with Blockly programming to navigate their drones through the obstacle course.
- Encourage collaboration and problem-solving within groups.
- Provide support and guidance as needed.

Explanation (Recap) - 15 minutes:

- Gather students for a group discussion on their experiences with Blockly programming and drone navigation.
- Recap the key concepts learned during the activity, including loops and conditional statements.
- Emphasize the importance of precision and accuracy in programming for successful drone navigation.
- Showcase examples of well-executed Blockly programs from different groups.
- Address any questions or challenges faced by the students.

Elaboration (Extension) - 30 minutes:

- Introduce optional materials for additional coding challenges, such as colored construction paper.
- Encourage students to enhance their Blockly programs by incorporating loops, conditional statements, and creative commands.
- Set up landing pads or hoops as additional challenges for precision drone landing or navigation through specific pathways.
- Allow students to customize their obstacle courses using the provided materials.
- Facilitate a mini-showcase where each group demonstrates their optimized Blockly programs and solutions to challenges.

Evaluation:

- Assess students based on their ability to successfully program the CoDrone drones using Blockly.
- Evaluate teamwork, collaboration, and problem-solving skills during the activity.
- Review engineering journals or worksheets for documentation of programming processes and reflections.
- Provide constructive feedback on the precision and accuracy of drone navigation through the obstacle course.

This lesson not only introduces students to the exciting world of drone programming but also fosters teamwork and problem-solving skills through hands-on activities. The optional materials and extension activities allow for differentiation, catering to various learning styles and skill levels.

Resources

Possible Bibliographies/ Works Cited

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Appendix

Educational Standards:

Common Core State Standards (CCSS):

- ELA-LITERACY.RI.4.7: Interpret information presented visually, orally, or quantitatively.
- ELA-LITERACY.RI.5.7: Draw on information from multiple print or digital sources.
- ELA-LITERACY.RI.6.7: Integrate information presented in different media or formats.
- ELA-LITERACY.RST.6-8.3: Follow precisely a multistep procedure.
- ELA-LITERACY.RST.6-8.7: Integrate quantitative or technical information expressed in words.
- ELA-LITERACY.RST.6-8.9: Compare and contrast information gained from different sources.
- MATH.PRACTICE.MP5: Use appropriate tools strategically.
- MATH.PRACTICE.MP7: Look for and make use of structure.

CSTA Computer Science Standards:

- 1B-CS-03: Determine potential solutions to solve hardware and software problems.
- 1B-AP-09: Create programs that use variables to store and modify data.
- 1B-1P-10: Create programs that include sequences, events, loops, and conditionals.
- 1B-AP-15: Test and debug a program or algorithm.
- 1B-AP-17: Describe choices made during program development.
- 2-CS-03: Systematically identify and fix problems.
- 2-AP-11: Create named variables.
- 2-AP-12: Design and iteratively develop programs.

ISTE Standards for Students:

- ISTE 5D: Understand automation and use algorithmic thinking.
- ISTE 6A: Choose appropriate platforms and tools.

Possible Bibliographies/Works Cited/Resources and Standards

Standards

9.1.12.B.4 Visual Arts

9.1.12.B.4.1 Paint

CCSS.Math.Content.K.MD.A.1 Describe measurable attributes of objects, such as length or weight. Describe several measurable attributes of a single object.

CCSS.Math.Content.K.MD.A.2 Directly compare two objects with a measurable attribute in common, to see which object has "more of"/"less of" the attribute, and describe the difference.

CCSS.Math.Content.1.MD.B.3 Tell and write time in hours and half-hours using analog and digital clocks.

CCSS.Math.Content.1.MD.C.4 Organize, represent, and interpret data with up to three categories; ask and answer questions about the total number of data points, how many are in each category, and how many more or less are in one category than in another.

CCSS.Math.Content.2.MD.A.1 Measure the length of an object by selecting and using appropriate tools such as rulers, yardsticks, meter sticks, and measuring tapes.

CCSS.Math.Content.2.MD.A.2 Measure the length of an object twice, using length units of different lengths for the two measurements; describe how the two measurements relate to the size of the unit chosen.

CCSS.Math.Content.2.MD.A.3 Estimate lengths using units of inches, feet, centimeters, and meters.

CCSS.Math.Content.2.MD.A.4 Measure to determine how much longer one object is than another, expressing the length difference in terms of a standard length unit.

CCSS.Math.Content.3.MD.D.8 Solve real-world and mathematical problems involving perimeters of polygons, including finding the perimeter given the side lengths, finding an unknown side length, and exhibiting rectangles with the same perimeter and different areas or with the same area and different perimeters.

CCSS.Math.Content.4.MD.B.4 Make a line plot to display a data set of measurements in fractions of a unit (1/2, 1/4, 1/8). Solve problems involving addition and subtraction of fractions by using information presented in line plots.

CCSS.Math.Content.4.MD.C.5a An angle is measured concerning a circle with its center at the common endpoint of the rays, by considering the fraction of the circular arc between the points where the two rays intersect the circle. An angle that turns through 1/360 of a circle is called a "one-degree angle," and can be used to measure angles.

CCSS.Math.Content.4.MD.C.5b An angle that turns through n one-degree angles is said to have an angle measure of n degrees.

CCSS.Math.Content.4.MD.C.6 Measure angles in whole-number degrees using a protractor. Sketch angles of specified measure.

CCSS.Math.Content.4.MD.C.7 Recognize angle measure as additive. When an angle is decomposed into non-overlapping parts, the angle measure of the whole is the sum of the angle measures of the parts. Solve addition and subtraction problems to find unknown angles on a diagram in the real world and mathematical problems, e.g., by using an equation with a symbol for the unknown angle measure.

CCSS.Math.Content.K.G.A.1 Describe objects in the environment using names of shapes, and describe the relative positions of these objects using terms such as above, below, beside, in front of, behind, and next to.

CCSS.Math.Content.K.G.A.2 Correctly name shapes regardless of their orientations or overall size.

CCSS.Math.Content.K.G.A.3 Identify shapes as two-dimensional (lying in a plane, "flat") or three-dimensional ("solid").

CCSS.Math.Content.K.G.B.4 Analyze and compare two- and three-dimensional shapes, in different sizes and orientations, using informal language to describe their similarities, differences, parts (e.g., number of sides and vertices/"corners"), and other attributes (e.g., having sides of equal length).

CCSS.Math.Content.K.G.B.5 Model shapes in the world by building shapes from components (e.g., sticks and clay balls) and drawing shapes.

CCSS.Math.Content.K.G.B.6 Compose simple shapes to form larger shapes.

CCSS.Math.Content.2.G.A.1 Recognize and draw shapes having specified attributes, such as a given number of angles or a given number of equal faces. Identify triangles, quadrilaterals, pentagons, hexagons, and cubes.

CCSS.Math.Content.2.G.A.2 Partition a rectangle into rows and columns of same-size squares and count to find the total number of them.

CCSS.Math.Content.2.G.A.3 Partition circles and rectangles into two, three, or four equal shares, describe the shares using the words halves, thirds, half of, a third of, etc., and describe the whole as two halves, three thirds, four fourths. Recognize that equal shares of identical wholes need not have the same shape.

CCSS.Math.Content.5.G.A.1 Use a pair of perpendicular number lines, called axes, to define a coordinate system, with the intersection of the lines (the origin) arranged to coincide with the 0 on each line and a given point in the plane located by using an ordered pair of numbers, called its coordinates. Understand that the first number indicates how far to travel from the origin in the direction of one axis, and the second number indicates how far to travel in the direction of the second axis, with the convention that the names of the two axes and the coordinates correspond (e.g., x-axis and x-coordinate, y-axis and y-coordinate).

CCSS.Math.Content.5.G.A.2 Represent real-world and mathematical problems by graphing points in the first quadrant of the coordinate plane and interpreting coordinate values of points in the context of the situation.

CCSS.Math.Content.6.G.A.1 Find the area of right triangles, other triangles, special quadrilaterals, and polygons by composing them into rectangles or decomposing them into triangles and other shapes; apply these techniques in the context of solving real-world and mathematical problems.

CCSS.Math.Content.6.G.A.2 Find the volume of a right rectangular prism with fractional edge lengths by packing it with unit cubes of the appropriate unit fraction edge lengths and show that the volume is the same as would be found by multiplying the edge lengths of the prism. Apply the formulas $V = l\ w\ h$ and $V = b\ h$ to find volumes of right rectangular prisms with fractional edge lengths in the context of solving real-world and mathematical problems.

CCSS.Math.Content.6.G.A.3 Draw polygons in the coordinate plane given coordinates for the vertices; use coordinates to find the length of a side joining points with the same first coordinate or the same second coordinate. Apply these techniques in the context of solving real-world and mathematical problems.

CCSS.Math.Content.6.G.A.4 Represent three-dimensional figures using nets made up of rectangles and triangles and use the nets to find the surface area of these figures. Apply these techniques in the context of solving real-world and mathematical problems.

CCSS.Math.Content.7.G.A.1 Solve problems involving scale drawings of geometric figures, including computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale.

CCSS.Math.Content.7.G.A.2 Draw (freehand, with ruler and protractor, and with technology) geometric shapes with given conditions. Focus on constructing triangles from three measures of angles or sides, noticing when the conditions determine a unique triangle, more than one triangle, or no triangle.

CCSS.Math.Content.7.G.A.3 Describe the two-dimensional figures that result from slicing three-dimensional figures, as in plane sections of right rectangular prisms and right rectangular pyramids.

CCSS.Math.Content.7.G.B.4 Know the formulas for the area and circumference of a circle and use them to solve problems; give an informal derivation of the relationship between the circumference and area of a circle.

CCSS.Math.Content.7.G.B.5 Use facts about supplementary, complementary, vertical, and adjacent angles in a multi-step problem to write and solve simple equations for an unknown angle in a figure.

CCSS.Math.Content.7.G.B.6 Solve real-world and mathematical problems involving area, volume, and surface area of two- and three-dimensional objects composed of triangles, quadrilaterals, polygons, cubes, and right prisms.

CCSS.Math.Content.HSG-SRT.A.1a A dilation takes a line not passing through the center of the dilation to a parallel line and leaves a line passing through the center unchanged.

CCSS.Math.Content.HSG-SRT.A.1b The dilation of a line segment is longer or shorter in the ratio given by the scale factor.

CCSS.Math.Content.HSG-SRT.A.2 Given two figures, use the definition of similarity in terms of similarity transformations to decide if they are similar; explain using similarity transformations the meaning of similarity for triangles as the equality of all corresponding pairs of angles and the proportionality of all corresponding pairs of sides.

CCSS.Math.Content.HSG-SRT.A.3 Use the properties of similarity transformations to establish the AA criterion for two triangles to be similar.

CCSS.Math.Content.HSG-SRT.B.4 Prove theorems about triangles.

CCSS.Math.Content.HSG-SRT.B.5 Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.

CCSS.Math.Content.HSG-SRT.C.6 Understand that by similarity, side ratios in right triangles are properties of the angles in the triangle, leading to definitions of trigonometric ratios for acute angles.

CCSS.Math.Content.HSG-SRT.C.7 Explain and use the relationship between the sine and cosine of complementary angles.

CCSS.Math.Content.HSG-SRT.C.8 Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.

CCSS.Math.Content.HSG-SRT.D.9 (+) Derive the formula A = 1/2 ab sin(C) for the area of a triangle by drawing an auxiliary line from a vertex perpendicular to the opposite side.

CCSS.Math.Content.HSG-SRT.D.10 (+) Prove the Laws of Sines and Cosines and use them to solve problems.

CCSS.Math.Content.HSG-SRT.D.11 (+) Understand and apply the Law of Sines and the Law of Cosines to find unknown measurements in right and non-right triangles (e.g., surveying problems, resultant forces).

CCSS.Math.Content.HSG-C.A.1 Prove that all circles are similar.

CCSS.Math.Content.HSG-C.A.2 Identify and describe relationships among inscribed angles, radii, and chords.

CCSS.Math.Content.HSG-C.A.3 Construct the inscribed and circumscribed circles of a triangle, and prove properties of angles for a quadrilateral inscribed in a circle.

CCSS.Math.Content.HSG-C.A.4 (+) Construct a tangent line from a point outside a given circle to the circle.

K-PS2-1 Plan and investigate to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.

K-PS2-2 Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull.

3-PS2-1 Plan and investigate to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.

3-PS2-2 Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.

Patterns in the natural and human-designed world can be observed and used as evidence.

Patterns in the natural world can be observed, used to describe phenomena, and used as evidence.

Patterns in the natural and human-designed world can be observed.

Patterns in the natural world can be observed.

Patterns of change can be used to make predictions.

Similarities and differences in patterns can be used to sort and classify natural phenomena.

Similarities and differences in patterns can be used to sort and classify designed products.

Patterns can be used as evidence to support an explanation.

Similarities and differences in patterns can be used to sort, classify, communicate, and analyze simple rates of change for natural phenomena.

Patterns can be used to identify cause-and-effect relationships.

Graphs, charts, and images can be used to identify patterns in data.

Patterns in rates of change and other numerical relationships can provide information about natural systems.

Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

Empirical evidence is needed to identify patterns.

Simple tests can be designed to gather evidence to support or refute student ideas about causes.

Events have causes that generate observable patterns.

Cause and effect relationships are routinely identified.

Cause and effect relationships are routinely identified, tested, and used to explain change.

Cause and effect relationships are routinely identified and used to explain change.

Cause and effect relationships may be used to predict phenomena in natural or designed systems.

Cause and effect relationships may be used to predict phenomena in natural systems.

Phenomena may have more than one cause, and some cause-and-effect relationships in systems can only be described using probability.

Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation.

Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

Systems can be designed to cause a desired effect.

Cause and effect relationships can be suggested and predicted for complex natural and human-designed systems by examining what is known about smaller-scale mechanisms within the system.

People depend on various technologies in their lives; human life would be very different without technology.

Every human-made product is designed by applying some knowledge of the natural world and is built using materials derived from the natural world.