UNIT OVERVIEW

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UNIT ONE OVERVIEW

DOWNLOAD THE APP

The UKIT app makes it easy for educators and students to successfully build, program, and manipulate every UKIT project. Download the free app to explore on your own, then ensure your students have the app downloaded on their devices as well. UBTECH Education solutions run on IOS or Android-based devices.

LEARNING GOALS

LESSON 1: MAKING A ROBOT MOVE

Working in GROUPS of 2–4, STUDENTS PLAN A WAY to investigate commands in the app, OBSERVE the results, and DOCUMENT their observations.

Groups analyze their observations by looking for patterns in the actions of the robot. Students use those patterns as evidence to identify CAUSE AND EFFECT relationships between the app commands and the actions of the robot.

During discussion, students DESCRIBE THE WAYS the class looked for patterns, observed, and made comparisons as they planned and conducted their investigations.

Students explain how each force acts on one particular object using their observations of the patterns in the Golf Club robot's and the model golf ball's motion. In their explanation, students identify when objects in contact exert forces on each other.

LESSON 2: PROGRAMMING A HOLE-IN-ONE

Working in GROUPS, students design a program that they believe will place a model golf ball in a specified target. THEN STUDENTS PLAN A FAIR WAY TO TEST THEIR PROGRAMS THAT USES A SET NUMBER OF TRIALS AND CONTROLS VARIABLES. Students observe the results to PRODUCE DATA TO SERVE AS EVIDENCE of the PATTERN of motion CAUSED by their program.

Students use the pattern of motion to predict where the model golf ball will land. Based on those predictions, students plan modifications to their program that will change the size or direction of the force acting on the golf ball. They explain how a change to the size or direction of the force WILL AFFECT (CAUSE) the pattern of the golf ball's motion.
LESSON 3: DESIGNING A BETTER GOLF CLUB

Working in groups, students **DEFINE A DESIGN PROBLEM** in response to the Lesson 3 Driving Question and the **DEMAND FOR AN IMPROVEMENT** to their Lesson 2 robot designs.

Working in groups, students **COLLABORATIVELY PLAN AND CONDUCT A FAIR WAY TO TEST** modifications to the prototype Golf Club robot that use a set number of trials, control variables, and generate data. That data can be used to judge the effectiveness of their design.

During tests of the modified robot design students carefully observe the results to **GENERATE DATA TO SERVE AS EVIDENCE** of the **PATTERNS** of motion of the model golf ball. Students identify **CAUSE AND EFFECT** relationships between the motion of the golf ball and the variables of the golf club.

Students use the **PATTERNS IN THEIR OBSERVATIONS AND DATA TO PREDICT** where the model golf ball will land. Based on those predictions, students plan modifications to their design that will change the size or direction of the force acting on the golf ball. They **EXPLAIN** how a change to the size or direction of the force will **AFFECT (CAUSE)** the **PATTERN** of the golf ball’s motion.

BACKGROUND FOR THE TEACHER

Robots can be used to solve a variety of problems in society. Many robots solve problems using movement that may be controlled by servos, or specialized motors that move parts of the robot and give feedback about the position of those parts to the robot’s computer. Robots also require programs, which are sets of commands in the robot’s computer.

Students may have encountered a variety of robots in their daily lives including Automated Teller Machines (ATMs) and automated carwashes. Robots also exist in hospitals and laboratories.

The game of golf has been played by many people throughout the world. Golf involves striking a ball with a club to drive the ball into a small hole in the ground. Golf involves the use and control of physical forces, so playing golf is a task that can be accomplished by a robot. Designing a robot to play golf is a way for students to learn about forces and robots to plan solutions to problems in their daily lives.
**UNIT SEQUENCE**

<table>
<thead>
<tr>
<th>LESSON</th>
<th>DRIVING QUESTION</th>
<th>DESCRIPTION</th>
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</thead>
<tbody>
<tr>
<td><strong>BACKGROUND AND DEVELOPING ENGAGEMENT</strong></td>
<td>How do robots solve problems?</td>
<td>Students consider the problems that could be solved by robots in their daily lives and in the future.</td>
</tr>
<tr>
<td><strong>LESSON 1: MAKING A ROBOT MOVE</strong></td>
<td>How do you make the robot move?</td>
<td>Students brainstorm ways to test the sample code of the robot.</td>
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<tr>
<td><strong>LESSON 2: PROGRAMMING A HOLE-IN-ONE</strong></td>
<td>How do you program the Golf Club robot to make a “hole in one”?</td>
<td>Using the Golf Club robot students explore how programmed commands change the rate and size of the robot’s movements to understand what cause and effect relationships are at work and to plan and test modifications to the program.</td>
</tr>
<tr>
<td><strong>LESSON 3: DESIGNING A BETTER GOLF CLUB</strong></td>
<td>How would you change the Golf Club robot so that it can drive a model golf ball over a greater distance?</td>
<td>Using the Golf Club robot as a prototype, students redesign a robot golf club to extend its range.</td>
</tr>
<tr>
<td><strong>UNIT ASSESSMENT</strong></td>
<td>How do robots solve problems?</td>
<td>Students explain how the problems in their daily lives or in the future could be solved by robots.</td>
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**Time Estimate**

250–300 minutes (five to six 50-minute sessions)

**TEACHING THE UNIT**

- Use the Unit Introduction to discuss the use of robots with students and to assess student ideas about robots, golf, and forces.
- Review the Lessons and activities of this Unit and consider how they will develop student ideas. Consider emphasizing certain parts of the Lessons or adding instruction to better meet the needs of your students.
- Teach the Lessons.
- Use the Unit Assessment to measure student learning and to guide other instruction.
UNIT INTRODUCTION

Robots are used in many ways. Robots are machines that follow the directions in a computer to perform different actions.

Robots can perform simple tasks in a laboratory like filling many jars with chemicals so that tests can be performed.

Robots can be used in hospitals. For example, robots can hand out medicine to doctors and nurses, who then give the medicine to patients.

You have probably seen an Automated Teller Machine (ATM) in a bank. An ATM is a type of robot.

All robots are used to solve different problems. The robots shown here all use movement. But how do robots move? This Unit will teach you about robotic movement so that you can use robots to solve problems in daily life!

The Challenge: Golf is a sport where people use clubs to hit a ball into a small hole. Using science terms, good golfers use force to move the ball. Programming and designing a robot to use force to move a golf ball can be a fun way to learn how to use robots, so your challenge is to design a robot to play golf.

Pre-Assessment and Discussion: Golf has been played for many years, by many people.
Discussion Questions:
Have you played golf?

How do you think a golf club uses force to move a golf ball?

What might be some important parts of a golf club?

How should a golf club be swung to properly hit a golf ball?

How might a robot play golf?

Have you ever seen robots that might be able to play golf?

What were those robots like?
UNIT ONE TEACHER GUIDE

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47 NEXT GENERATION SCIENCE STANDARDS (NGSS) ELEMENTS DEVELOPED IN THIS LESSON
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DRIVING QUESTION

How do you make the robot move?

LEARNING GOALS

Working in GROUPS, STUDENTS PLAN A WAY to investigate commands in the app, OBSERVE the results, and DOCUMENT their observations.

Groups analyze their observations by looking for patterns in the actions of the robot. Students use those patterns as evidence to identify CAUSE AND EFFECT relationships between the app commands and the actions of the robot.

During discussion, students DESCRIBE THE WAYS the class looked for patterns, observed, and made comparisons as they planned and conducted their investigations.

Students explain how each force acts on one particular object using their observations of the patterns in the Golf Club robot’s and the model golf ball’s motion. In their explanation, students identify when objects in contact exert forces on each other.

GETTING STARTED

Time Estimate

100 minutes (two 50-minute sessions)

Materials for Each Group

• 1 UKIT and app interface–enabled device
• 1 plastic practice golf ball
• 4-foot section of butcher paper (enough to cover desk)
• Markers
• Student worksheets (pages 18–20 of this packet)
Lesson Resources
Student worksheets (pages 16–18 of this packet)

Vocabulary
- program
- servo
- robot

BACKGROUND FOR THE TEACHER

How Forces Affect Motion: Scientists use the idea of force to explain the motion of objects. A force may be a push or a pull, and when something pushes or pulls an object scientists say that a force acts on, or has been applied to, the object. Several forces can act on an object at one time and each force has a direction and magnitude. When scientists describe the forces acting on an object they pay attention to the direction and magnitude of each force. The directions and magnitudes of forces are important for identifying balancing forces and predicting motion. Balancing forces are forces that act in the opposite direction and with equal magnitude of any push or pull that is applied to an object. Meanwhile, when a force acts on an object and there is no balancing force a change will occur in an object’s motion.

Your students may be familiar with the idea that an object in motion will stay in motion in the same direction until another force acts upon it. A golf ball in motion, after having been hit by a golf club, is set in motion. It may be acted upon by several forces including gravity, which pulls it toward the Earth, and wind, which may push it in a new direction. It also encounters friction from the air and ground as it moves along its trajectory. When the ball is at rest, all the forces acting on it are in balance.
5E LESSON PLAN

The 5E model is a five-stage sequence teachers can apply to lessons and units. Developed originally for the Biological Sciences Curriculum Study, the 5E model is supported by a growing research base and is a great fit for problem-based learning, project-based learning, and the Universal Design for Learning framework.

**ENGAGE:** Sparks student interest; creates a personal connection to the lesson; assesses prior knowledge

**EXPLORE:** Allows students to develop their own understanding of the topic

**EXPLAIN:** Offers students opportunities to share what they have learned and explore what it might mean

**ELABORATE:** Invites students to apply new knowledge and gauge the impact of that knowledge on prior understanding

**EVALUATE:** Provides time for students to reflect on the lesson; assesses student learning and understanding

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**ENGAGE**

*Robots in Action*: Ask students to discuss the Driving Question: How do you make the robot move?

Use follow-up questions to prompt students to **THINK ABOUT AND DESCRIBE THEIR EXPERIENCES WITH, AND UNDERSTANDINGS OF, ROBOTS AND MOTION**.

For example:

- Have you ever **SEEN** a robot move or do you know someone who works with robots that move?
- Scientists use the concept of **CAUSE AND EFFECT** to solve problems. **WHAT COULD CAUSE** the parts of a robot to move?
- How can movement help a robot to perform its task?
- Do you think robots **ALWAYS MOVE IN THE SAME WAY**?
EXPLORE

**Build Your Robot:** Ask students to construct the Golf Club robot so that they can **EXPLORE** the ways it functions.

Direct them to follow the instructions in the app interface to construct the robot. Then ask them to connect their app-enabled device to the robot and run the robot’s sample program.

Once groups have all successfully constructed and tried their robots, ask students to **REFLECT ON THEIR EXPERIENCE** in a class discussion.

- Did the Golf Club robot work well?
- **HOW DID** the commands in the robot’s program **AFFECT** the robot’s movement?

**NOTE:**
Student should be in groups before they begin.
Each group should have a robot kit.
EXPLAIN

Strike Force: Ask students to **DESCRIBE HOW FORCES ARE EXERTED BY THE GOLF CLUB** robot on the model golf ball.

- What forces **ACT** on the golf ball?
- When does the robot **APPLY A FORCE** to the golf ball?
- How does the force **AFFECT** the golf ball?

Direct students to work together to **DRAW A PICTURE** of the Golf Club robot on their piece of butcher paper. Ask them to use arrows to show any forces that act on the golf ball at the moment the golf club strikes the ball. Walk around the classroom and observe the groups working. Use this as an opportunity to assess student understanding of forces. Consider discussion questions that will develop student understandings of force.

Create a class list of forces that act on the golf ball at the moment that it is struck. Explain that forces act on the golf ball even before it is struck. Point out that when students press downwards on the golf ball they are applying a force, but the golf ball doesn’t move. Use this to explain the term balancing force. Then point out that the golf ball doesn’t move when students stop pressing the ball downwards because forces are still **BALANCED**.

Draw a force diagram like this:
**ELABORATE**

**Investigation Plan:** Ask students to describe the way the robot works to exert force on the ball.

- How did the robot exert force when you tried it earlier? What did you have to do to **CAUSE** the robot to work? What happened next?
- Did you notice that you can change the settings in the robot’s program?
- Do you know all the ways you can change the settings in the robot’s program?
- How would you investigate the way changes to the settings in the robot’s program **AFFECT** the robot’s swing?

Direct students to create a plan for the way they would investigate the settings in the robot’s program. Students should plan their investigation using the “Investigation Plan” table. Once students have created a plan, direct students to use their plan to investigate the way the settings in the robot’s program can be changed, and the effects of those changes.

**INVESTIGATION PLAN**

Answer the questions in the table below with notes and/or drawings to explain how you would investigate the Golf Club robot.

<table>
<thead>
<tr>
<th>What are you trying to learn or test with your investigation?</th>
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<table>
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<tr>
<th>What steps will you follow to complete your investigation or test?</th>
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<table>
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<th>How will you record your observations?</th>
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</table>
**EVALUATE**

**What We Learned:** After students have completed their own investigations ask the class to describe what they learned.

- What are the ways that you can use different settings in the program to make the robot move?
- How do you *know* this? *How did you investigate* those settings?
- Recognizing *patterns* is an important way that scientists gather information. What *patterns* did you see in the robot’s motion? How did you see the robot’s movement change? Was there a pattern in the way the movement changed during your investigation?
- What *caused* the changes in the robot’s movement?
- Will the robot *always move in the same manner*?

Keep track of student answers and ideas on a piece of butcher paper. Keep the butcher paper as a visual record of student understandings of the robot’s programing language.

**GUIDING THE INVESTIGATION**

During instruction, student performances should include more crosscutting concepts and practices than those emphasized in the below Next Generation Science Standards (NGSS) Connections table and Learning Goals. The following tables summarize the additional concepts and practices incorporated during the 5E Lesson Plan.
**NGSS ELEMENTS DEVELOPED IN THIS LESSON**

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<tr>
<td><strong>3-PS2-1</strong> Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.</td>
<td>Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered. (3-PS2-1)</td>
<td>Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost. (3-5-ETS1-1)</td>
<td>Science investigations use a variety of methods, tools, and techniques. (3-PS2-1)</td>
<td>Science findings are based on recognizing patterns. (3-PS2-2)</td>
<td>Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object’s speed or direction of motion. (3-PS2-1)</td>
<td>Objects in contact exert forces on each other. (3-PS2-1)</td>
<td>The patterns of an object’s motion in various situations can be observed and measured; when that past motion exhibits a regular pattern, future motion can be predicted from it. (3-PS2-2)</td>
<td>Cause and effect relationships are routinely identified. (3-PS2-1)</td>
<td>Patterns of change can be used to make predictions (3-PS2-2)</td>
<td>People’s needs and wants change over time, as do their demands for new and improved technologies. Engineers improve existing technologies. (3-5-ETS1-1)</td>
</tr>
<tr>
<td><strong>3-PS2-2</strong> Make observations and/or measurements of an object’s motion to provide evidence that a pattern can be used to predict future motion.</td>
<td>Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. (3-PS2-2)</td>
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DRIVING QUESTION
How do you make the robot move?

INTRODUCTION
Scientists use the idea of force to explain the motion of objects, like the Golf Club robot or a golf ball. A force may be a push or a pull. In this Lesson, you need to explore the way the robot works to exert force on the golf ball so that you can design a way for the robot to play golf.

SAFETY REMINDERS
Be sure to keep your eyes away from the Golf Club robot.

MATERIALS LIST
• 1 UKIT and app interface–enabled device
• 1 plastic practice golf ball
• 4-foot section of butcher paper (enough to cover desk)
• Markers

ACTIVITY PROCEDURE
1. Follow your teacher’s directions to open the app. Then follow the directions in the app to construct the Golf Club robot.
2. Try to make the Golf Club robot hit the practice golf ball.
3. Follow your teacher’s directions to create an Investigation Plan.