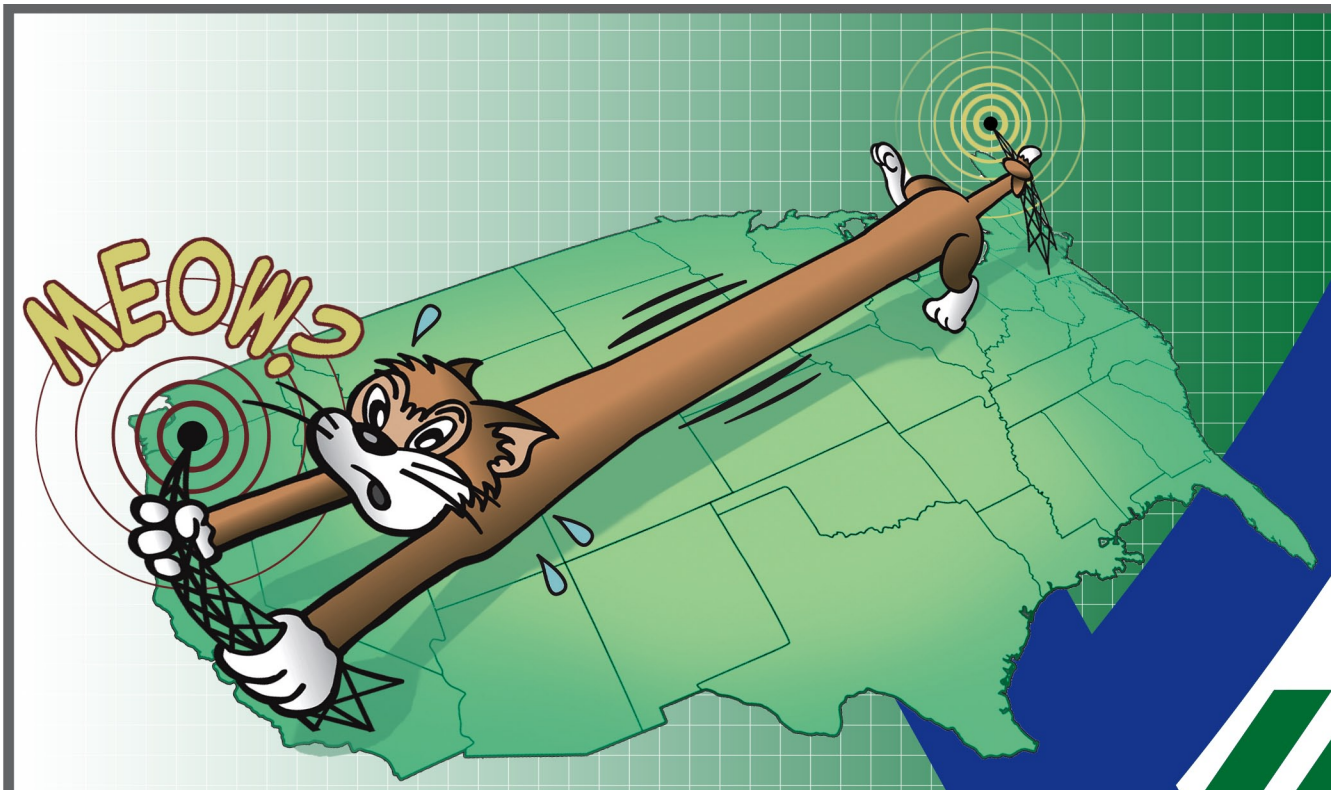

WARNING: The Wireless Burglar Alarm Electronics kit is longer available.

We will continue to look for viable alternatives and will revise Activities 2, 3, and 4 at a later date if possible. For now, we advise against using this module.

Wireless Burglar Alarm

TechXcite

Discover Engineering

Facilitator's Guide

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Table of Contents

Module Overview

This **TechXcite: Discover Engineering** module introduces youth to the fascinating technology of signal transmission. It is an interdisciplinary engineering project for students to build an alarm system that could be used in their own rooms. An alarm system needs a sensor to detect an intruder, a transmitter to send the signal, and a receiver to trigger an alarm to warn the user.

This curriculum is intended for use in informal settings, such as after-school programs and summer camps, for youth in the middle school grades. However, it has been successfully implemented in formal contexts, such as in-school activities including homeschool content, and youth older and younger than middle school grades.

Activity 1: Youth experiment with a simple switch that they must fit to a door to trigger the alarm.

Activity 2: Youth build a transmitter and receiver that send and receive a signal via wires.

Activity 3: Youth modify the wired transmitter and receiver by adding a radio frequency chip that allows them to remove the wire and explore how an antenna affects transmission range.

Activity 4: Youth put the whole project together to allow the door trigger created in Activity 1 to trigger a message they record at the receiver.

At the end of this module, each pair of students will have designed and built their own wireless burglar alarm system. Students utilize electrical engineering and mechanical engineering to create these practical alarm systems.

TechXcite: Discover Engineering

TechXcite is an informal engineering program partnering 4-H Youth Development/Family and Consumer Sciences at North Carolina State University, National 4-H Council and the Engineering K-PhD Program at Duke University's Pratt School of Engineering. It was initially funded by a five-year grant from the National Science Foundation.

In 2000, Drs. Ybarra and Klenk created an informal after-school engineering program at Rogers-Herr Middle School in Durham called Techtronics, which spread to additional schools across North Carolina and other states. The TechXcite: Discover Engineering curriculum builds on the Techtronics foundation by implementing hands-on, exploratory, engineering learning modules in 4-H Afterschool programs nationwide. Other after-school programs and even formal in-school and home-school programs have chosen to use the TechXcite curriculum. TechXcite is an engaging, substantive, experiential and inquiry-based curriculum centered on engineering, while using technology, applied science and mathematics learned in school. TechXcite's mission is to encourage youth in both rural and urban settings to pursue careers in engineering and technology.

TechXcite is the product of a collaboration of twelve 4-H leaders at land grant universities, two leaders at National 4-H Council and a team at Duke University.

Online Support

The TechXcite website (techxcite.org) contains additional material to facilitate implementation of this module. There are videos, Facilitator's Guides, Youth Handouts, and kit inventories with vendors and pricing for each item required. Although the curriculum is written with a focus on middle school youth, it has been successfully implemented at both the elementary and high school levels. Anyone can download copies of the Facilitator's Guide and Youth Handouts from our website. There are links to additional resources for information about the module topics and ideas for further activities and exploration.

Training Videos

Each module comes with a set of training videos found on its curriculum page (techxcite.org/curriculum). These videos serve as a companion to the Facilitator's Guide. An introductory video provides an overview of the material and concepts. The corresponding video for each activity then covers basic setup, procedure, and helpful tips for facilitating that activity. It's recommended that instructors watch all of the videos before starting the module.

Using This Guide

The Facilitator's Guide for each activity follows the same format. Below is what you can expect to find in each section. At the beginning, you will be given basic information about the activity. This includes:

- Time Required
- Group Size – Suggested number of students per group.
- Materials List
- Youth Handouts – These will need to be copied.
- Getting Ready – Includes what you need to do before the activity and approximately how much time it will take you.
- Learning Objectives
- Vocabulary

Introduction and Activity Closure

The Introduction and Activity Closure are scripted. You may read these sections verbatim to students. Instructions that are not to be read to students, as well as answers to questions, are in brackets/italics.

Facilitating the Activity

This section contains step-by-step instructions for facilitating the activity. Students have their own procedure in the Youth Handouts.

Assessment

This section tells you how to assess whether or not students understood the material presented to them in the activity. These assessments are generally based on students' answers to questions asked during the Activity Closure section.

Activity 1: Electric Door Trigger

Time Required: 45 Minutes **Group Size:** 2-3

Materials List

Each group needs:

- 2 Long wires (about 3 feet)
- 2 Short wires (about 6 inches)
- AA battery
- Lamp holder
- Lamp
- Small sheet of aluminum foil

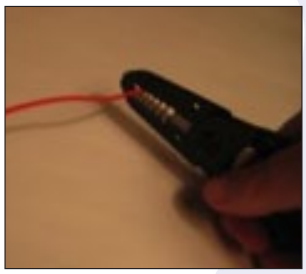
Each class needs:

- Scotch tape or electrical tape
- Wire strippers

Youth Handouts:

- "Electric Door Trigger"

Getting Ready (10-20 minutes)



- Tear off strips of aluminum foil (one strip of 4 inches for each group).
- If the wires have not been cut and stripped already, cut 2 long pieces of wire (about 3 ft) and 2 short pieces of wire (about 6 in) per group. Use the wire stripper to remove the insulation from the last ½" of the wire ends (see picture). You could teach the students to do this during the activity if there is extra time.

Learning Objectives

- Create a circuit that lights a bulb with a wire and a battery.
- Explain why aluminum foil conducts electricity and demonstrate this by building a circuit using an aluminum foil switch.

Activity 1: Electric Door Trigger

Vocabulary

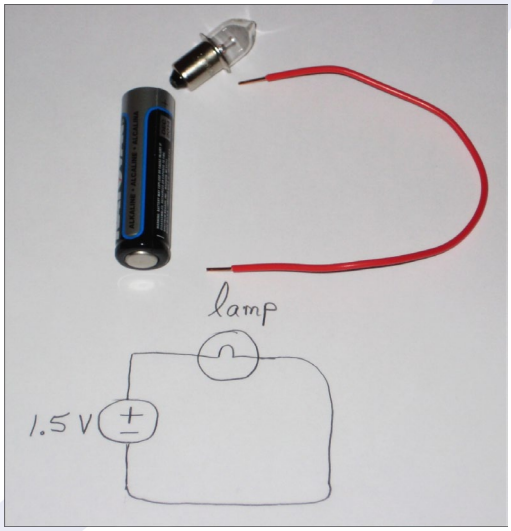
Word	Definition
Battery	Source of electrical energy.
Lamp	Device that converts electricity into light.
Wire	A conductor that carries electric current.
Switch	Device that turns electricity on or off.
Terminal	Positive or negative end of a device.
Short circuit	A direct connection between the positive and negative battery terminals (to be avoided).

Introduction

Over the next few activities, you are going to be designing a simple security system that will alert you when someone has entered your room or opened a box that you would prefer to keep to yourself. The alarm will consist of a trigger that will detect when the door has been opened. Then, we will learn how that signal can be transmitted without **wires** to alert you that somebody has gotten into your room using an LED on a receiver. Finally, we will record the sound the alarm will make to warn the intruder.

Today, we will build the trigger circuit. We'll start with a simple **lamp** circuit—something we use in our homes every day. Then, we are going to build a **switch** out of aluminum foil to turn the lamp on when a door or box is opened.

Facilitating the Activity



Part A: Basic Lamp Circuit

1. Split students into groups of 2-3.
2. Give each group a short wire, a lamp, and a **battery**. They do not need the handouts yet. This portion of the activity could begin individually as students are coming into the classroom.
3. Ask the students, "Can you light the lamp using just the one wire and battery?"
4. Give them a few minutes to try to do this. If they are not able to figure it out, you can show them using the picture at the right as your guide.
5. Pass out the "Electric Door Trigger" handouts.

Activity 1: Electric Door Trigger

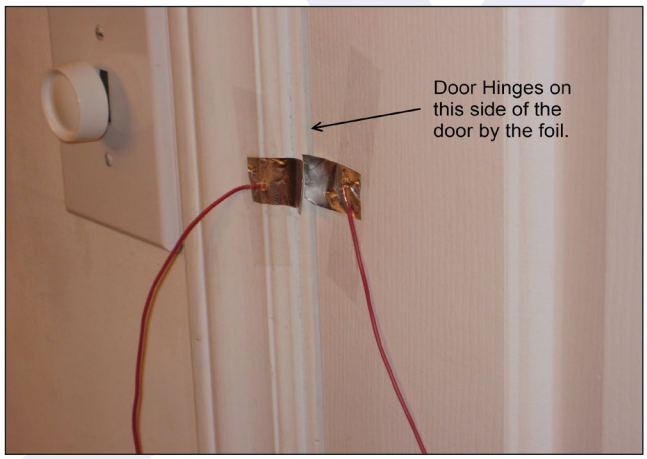
6. Instruct the students to look at their AA batteries closely. Then, tell them that the AA battery is a source of electrical energy. The ends are called **terminals**. The positive terminal is marked with a "+" sign and has a small round metal tip. The negative terminal has a flat metal surface. All batteries have a positive end and a negative end.
7. Tell students that they should never connect the positive and negative ends of a battery to each other directly. This is a **short circuit**! A short circuit will drain the battery quickly and cause the battery to over heat.
8. Instruct the students to look at their lamps closely. The lamp converts electricity into light. It has two terminals and electricity flows in one terminal and out the other when connected to the positive and negative battery terminals. The metal tip on the bottom of the lamp is one terminal and the metal case around the bottom is the other (see arrows in picture at right).

Part B: Aluminum Foil Switch

9. Pass out another short wire and a small piece of aluminum foil to each group.
10. Ask the students to follow the instructions in Part B to build a switch using aluminum foil.
11. Walk around and help the students as they work through the activity. If the students are not able to get their lamps to light up, help them figure out why. Make sure the bottom terminal of the lamp is touching the battery.

Part C: Engineering Design Challenge

12. Once they have built the circuit with a small foil switch, tell the class that it is time for them to design a door trigger switch. As engineers, they must complete the engineering design challenge on the last page of the handout. Instead of a door, this could be done with a cabinet or a box. Assign each group to a door, cabinet, or box.
13. Again, walk around and help the students as they work through the activity. If the students are not able to get their lamps to light up, help them figure out why. An example is shown below to help you assist them. Encourage the students to be creative.
14. If a group asks to use more aluminum foil, ask them to explain their design to you. You should provide them with extra foil as long as they describe a design that requires the extra foil and are not just asking for it to play with it. Encourage their creativity by telling them you're excited to see what they have in mind.
15. If groups finish early, ask them to answer the question on the last page of their handouts.
16. At the end of the activity, collect all of the reusable components (wire, batteries, lamps, lamp holders, unused aluminum foil, etc.)



Activity 1: Electric Door Trigger

Activity Closure

Would any of you like to explain how your door trigger switch works?

[*Encourage a few of them to show their switches to the group.*]

How would you improve your door trigger switch?

[*Let them think about it, and wait for one or two answers. Examples: Make it stronger. If they do not list strength, you could ask if they think the trigger would work 100 times or 1000 times or ask if it would ever break. Another way they might think to improve it would be to make it less visible to an intruder. A final example that is suggested in the handout is better materials. If they suggest better materials, ask them, "What materials would be better and why?" In answering this question they need to remember that the materials that connect the circuit must conduct electricity.*]

Assessment

Describe how the lamp circuit works. They should be able to describe a lamp as taking electricity and converting it into light if they have understood the material. You might ask them to write or diagram this to help solidify the concept.

Activity 2: Wired Communication

Time Required: 45 Minutes **Group Size:** 2-3

Materials List

WARNING: Activity not possible due to missing Wireless Burglar Alarm Electronics kit!

Each group needs:

Transmitter
- Encoder chip with gold dot (R-8PE Encoder integrated circuit)
- 2 Switches
- 2 Resistors (100 kΩ - brown black yellow)
- 3 Jumper wires (2")
- Battery pack for 3 AA batteries
- Breadboard

Receiver
- Decoder chip with silver dot (R-8PD Decoder integrated circuit)
- 2 LEDs
- 3 jumper wires (2")
- 3 Jumper wires (2")
- Battery pack for 3 AA batteries
- Breadboard

- 2 Long wires (about 3' each same as Activity 1)
- 6 AA batteries

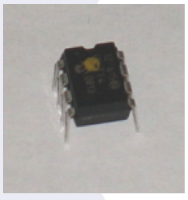
Each class needs:

- Tape measure

Youth Handouts:

- "Wired Communication"

Getting Ready (10 minutes)



- Lay out the transmitter and receiver bags, the long wires, the batteries, and the tape measure on a front table. This will help in distributing materials to the students.
- Check each transmitter bag to make sure it contains 1 encoder chip with a gold dot.
- Check each receiver bag to make sure it contains 1 decoder chip with a silver dot.

Note: The encoder and decoder chips look nearly identical, but you can tell them apart by the silver (decoder) and gold (encoder) dots.

Activity 2: Wired Communication

Learning Objectives

- Explain the purpose of the encoder and decoder chips in communication.
- Explain wired communication and its advantages and limitations.

Vocabulary

Word	Definition
Encoder	A device that converts a message into a signal suitable to transmit.
Decoder	A device that receives a signal and recovers the message that was sent.

Introduction

In the previous activity, you built a door trigger circuit for an alarm system. The circuit turned on a light bulb when a door opened. Now we need to transmit that information somewhere else. Today, we will explore how this can be done with wires. Next time, we will learn to transmit information wirelessly.

Can you think of examples of systems that transmit information using wires?

[*Allow the students some time to think about this and provide some answers.*]

Wired communication systems are very common and provide services such as telephone, Internet access, and cable television. Today, we are going to build a simple wired transmitter and receiver that will allow us to control lights on the receiver with switches on the transmitter. As you may recall from last time, these switches can be as simple as two pieces of aluminum foil.

Facilitating the Activity

1. Split students into groups of 2-3.
2. Pass out electronic components except the battery pack. Only give the students the battery pack after they have completed the rest of their circuit.
3. Walk around and help the students as they work through the activity. Help the students check to make sure their circuits are built correctly. If the transmitter/receiver pair doesn't appear to work, ask the students to disconnect the battery pack from the breadboard and follow the troubleshooting procedure in the student handout.
4. When the activity is completed, ask the students to keep the circuits assembled.
5. Disconnect the batteries and have somebody collect them. The batteries go back in the boxes to keep the contacts from touching and creating a short circuit.
6. Also disconnect the transmitter from the receiver and put the two circuits in the bags their components came in. These will be used in the next activity.
7. Collect the circuits from the students.

Activity 2: Wired Communication

Activity Closure

What was the hardest part of putting the circuit together? Why?

[*Give the students time to answer.*]

You now have a transmitter and receiver that are connected by two wires. Imagine that the transmitter is in the kitchen at your house and the receiver with two LEDs is in your bedroom connected with long wires between your bedroom and kitchen. Your mom or dad can use those switches to turn the two LEDs in your room on and off. How many messages can your parents send to you in your room by turning the two LEDs on and off? Describe how they would send the messages.

[*There are a number of correct answers to this so it is important to let the students describe their answers. For example, there are 4 combinations of the two LEDs (on-on, off-off, on-off, off-on). As another example, students may also realize that they can convey more than 4 different messages by turning one or both lights on and off similar to Morse code. In this manner, they could transmit any number of messages.*]

What messages might you transmit using this kind of system?

[*Give the students time to answer.*]

Next time, you will modify this transmitter and receiver to send the signal without wires.

Assessment

Students' answers to the types of messages they would be interested in transmitting will tell whether or not they understood the material. Messages need to be conducted from one fixed location to another fixed location because they are transmitted by wire.

When asked, students should also be able to explain that the purpose of the **encoder** and **decoder** chips is to allow multiple messages (2 LEDs on or off) over two wires (one for the signal and one for ground).

Activity 3: RF Wireless Communication

Time Required: 45 Minutes **Group Size:** 2-3

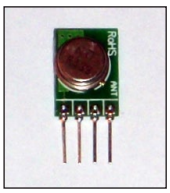
Materials List

WARNING: Activity not possible due to missing Wireless Burglar Alarm Electronics kit!

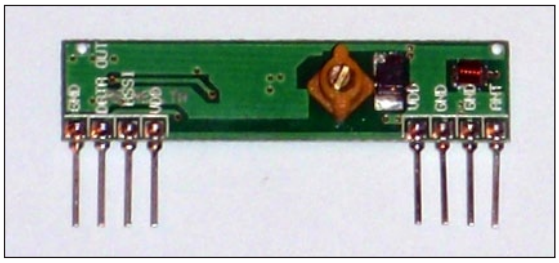
Each group needs:

- Transmitter circuit (from Activity 2)
- Receiver circuits (from Activity 2)
- RF Transmitter chip (TWS-434A)
- RF Receiver chip (RWS-434)
- Jumper wires (2")

Transmitter



Receiver



Each class needs:

- Tape Measure

Youth Handouts:

- "Wireless Communication"

Getting Ready (10 minutes)

- Lay out the transmitter and receiver circuits students built during Activity 2.

Learning Objectives

- Explain that a radio frequency (RF) link can replace a wired link.
- Explain that an antenna extends the range of a radio frequency (RF) link.
- Discuss advantages and disadvantages of wireless vs. wired communication systems.

Vocabulary

Word	Definition
RF (Radio Frequency)	A type of invisible light often used to transmit information wirelessly.
Antenna	A device used to improve RF communication by radiating or capturing radio waves.

Activity 3: RF Wireless Communication

Introduction

Last time you built a transmitter and receiver circuit, they were connected using two wires. This communication system allowed you to turn two LEDs on and off independently. Today, we will make the connection between the transmitter and receiver wireless.

What devices do you know that use radio waves to transmit information? [*Allow the students some time to think about this. Radios are the easiest example. Various other wireless systems also use radio waves including laptops, Bluetooth, keyless car entry, radio controlled (RC) cars, and cell phones.*]

Many devices you use transmit wireless signals with radio waves, which are known as radio frequencies or **RF**. Before we begin building RF wireless transmitters and receivers, let's talk briefly about radios in your car.

What is your favorite radio station? [*Many students will give you a number.*] This number is the frequency of the radio station in MHz (mega Hertz). For example, the station 106.1 is 106.1 MHz.

The transmitter for an FM radio station is located at the radio station and there is no limit to the number of radios that can receive the RF signal at one time. However, if there were two radio stations near each other that transmitted at the same frequency there would be interference and the radios tuned to this frequency would pick up both stations at the same time.

Keep this in mind as we begin converting our wired communication system into a wireless system. Once it is wireless, we can monitor our door trigger alarm system using the LEDs without wires.

Facilitating the Activity

1. Put the students back in their groups of 2-3 from the last activity.
2. Pass out electronic components.
3. Walk around and help the students as they modify first the receiver circuit and then the transmitter circuit. Help the students check to make sure their circuits are built correctly. If the transmitter/receiver pair doesn't appear to work, ask the students to disconnect the battery pack from the breadboard and help them follow the troubleshooting procedure in the youth handout.
4. Once students begin finishing, *test one group's transmitter circuit at a time*. If more than one transmitter circuit is used simultaneously, their signals could cross. Give each group a few minutes as the official testing circuit for the class so they all have the opportunity to test their circuits. Since all of the receivers will work with each transmitter, the entire class can test their receivers while one group is testing its transmitter.
5. When the activity is completed, ask the students to keep the circuits assembled.
6. Disconnect the batteries and have somebody collect them. The batteries go back in the boxes to keep the contacts from touching and creating a short circuit.
7. Also disconnect the transmitter from the receiver and put the two circuits in the bags their components came in. These will be used in the next activity.
8. Collect the circuits from the students.

Activity 3: RF Wireless Communication

Activity Closure

What are some things you can do with your wireless transmitter and receiver circuits that you couldn't do with your wired circuits?

[*Give the students time to answer. Answers might include that they can transmit over a longer distance and that they do not have to worry about obstacles for wires between the transmitter and receiver. Also, with the wireless system, the receiver can move around without tripping people on wires. In a house, this would mean the receiver can move around the house.*]

How far was the wireless signal able to transmit? What was the effect of the antenna?

[*Give the students time to answer based on their tests. Without the antenna, this will be approximately across the classroom. With the antenna, it can be down a hallway.*]

What might be some advantages of the wired system you built last time over the wireless system you built today?

[*Answers might include that the wired system is less expensive and more reliable. Also, it is more secure because other transmitters can't receive the signal in a wired system while they can with a wireless system.*]

Assessment

Describe what the two circuits are doing now and how these circuits differ from the ones they built last time. They should be able to tell you that the wires have been replaced with RF (radio frequency) transmitter and receiver chips. The range of these chips can be extended with antennas.

Activity 4: Sounding the Alarm

Time Required: 45 Minutes **Group Size:** 2-3

Materials List

WARNING: Activity not possible due to missing Wireless Burglar Alarm Electronics kit!

Each group needs:

- Aluminum Foil Door trigger (from Activity 1)
- RF Transmitter circuit on breadboard (from Activity 3)
- RF Receiver circuit on breadboard (from Activity 3)
- Sound recording module
- 2 Jumper wires (2")
- 4 Wires with alligator clips

Each class needs:

- Scotch tape
- Wire strippers
- Additional aluminum foil
- Additional long wires

Youth Handouts:

- "Sounding the Alarm"

Getting Ready (25 Minutes)

- Check the voice recording modules for each group to make sure they work and the message recorded on them is appropriate or no message at all. If one has an inappropriate message, record a blank message to reset it.
- Get out each of the transmitters and receivers built by the students in the previous class

Learning Objectives

- Explain why sound modules are attached to the alarm system.
- Explain that the sound recording module records sound on a chip on the circuit board.

Activity 4: Sounding the Alarm

Introduction

Over the last few weeks, we've built an alarm system you could use in a number of locations. It transmits information over a distance using a radio frequency transmitter and receiver. How far did the radio frequency transmitter and receiver communicate?

[*Provide the students with time to answer. Prompt them to think about their experiments during the last session with the transmitter and receiver. They will have found that without the antenna wire attached, the range is approximately across a room, while with the antennae wire attached, the range is down the hall somewhere.*]

When you listen to music on a radio, where is the receiver and where is the transmitter? How far apart are they?

[*Provide the students with time to answer. In this case, the transmitter is at the radio station and the receiver is in the car, which could be miles away.*]

The radio signals in your car are the same types of signals we're using with the transmitter. The difference is that the radio station has a much more powerful transmitter so your car can receive the signal much further away. As you work on your alarm system today, you may imagine that your transmitter has more power so that you can receive the signal farther away. For instance, if the system is for your bedroom, you could receive the signal while you are at school to warn you of an intruder.

Today, you are going to design an alarm system the way an engineer would design an alarm system. The most important part is to define the problem you are trying to solve and specify any performance requirements. You will then build a prototype to demonstrate and test your design. It is okay if there are performance requirements that you identify as necessary for the alarm but that the prototype cannot meet. You just need to describe what you would do to meet those requirements.

For instance, a requirement might be that the alarm trigger is difficult to see for somebody trying to get into the box. The aluminum foil might be big and easy to see on the prototype, but you could specify that the contacts will be much smaller and describe that the metal will be embedded in part of the door and the floor so that it is harder to see for an intruder.

After defining the problem you're trying to solve with an alarm system, you'll use the materials provided to put together a prototype alarm system to demonstrate your idea for the class.

Activity 4: Sounding the Alarm

Facilitating the Activity

1. Demonstrate to the students how to use the recording module by recording your voice on one of them. Press and hold down the record button until you hear the beep. Then start speaking. You will have 10 seconds of recording time.
2. Distribute the "Sounding the Alarm" handouts to each group and show them where to define the problem they are trying to solve and any specifications and constraints.
3. While they are working on the activity, walk around and make sure that each group has defined a particular problem. Help them be specific. For example:
    - If they say that the receiver must be shockproof, ask them to be more specific. This could be shockproof to something being dropped on it from a particular height or to it being dropped from a particular height.
    - If they say that the receiver must fit in a pocket, ask them to provide dimensions.
4. Many of the students will finish relatively quickly with recording. Ensure the students use two different door triggers if they connect the sound card. One should be for the transmitter and one should be for the sound alarm.
5. They could also have two alarms, one for each switch on the transmitter. Perhaps the first would be a silent alarm. The students can use these pieces to design the system.
6. When testing, work with the different groups so that only one transmitter is being used at a time.

Activity Closure

Describe your design problem and the solution you have developed. Did you learn anything from building the prototype that you would incorporate into the final design? What other ideas would you incorporate into a final design to meet your specifications? Be specific.

Assessment

Their design problems need to be specific but should not lend themselves to a single solution. Also, their designs should provide a plan to meet each of the identified constraints.

Tools Used in this Module

Electrical Breadboard

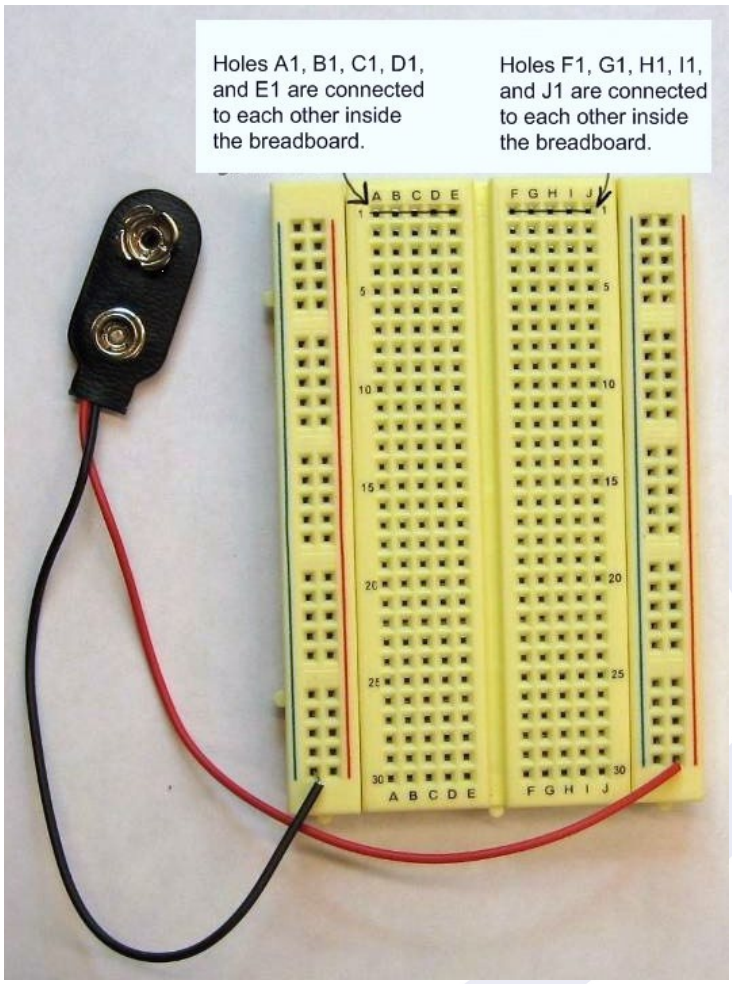
All holes in the outer vertical columns (power rails) are electrically connected inside of the breadboard. There are two power rails on the left side and two power rails on the right side. Generally, the blue power rail is negative and the red power rail is positive. In this module, we will one be using one rail on each side.

Note: Some breadboards have the red and blue power rails reversed from the picture.

All five holes in each row on one side of the center are connected together inside of the breadboard. However, the five holes on the left side of the center are NOT connected to the five holes on the right side.

For example:

- A1 is connected to D1
- A1 is NOT connected to A2
- A1 is NOT connected to F1



Glossary

Antenna
A device used to improve RF communication by radiating or capturing radio waves.

Decoder
A device that receives a signal and recovers the message that was sent.

Encoder
A device that converts a message into a signal suitable to transmit.

Battery
Source of electrical energy.

Lamp
Device that converts electricity into light.

RF (Radio Frequency)
A type of invisible light often used to transmit information wirelessly.

Short circuit
A direct connection between the positive and negative battery terminals (to be avoided).

Switch
Device that turns electricity on or off.

Terminal
Positive or negative end of a device.

Wire
A conductor that carries electric current.

Facilitator Tips

The Facilitator's Guide is provided as a reference tool for the Quest for Speed curriculum. It is not intended to replace curriculum-specific training. The following tips provide additional assistance for facilitators.

Think Safety

Promote an inclusive environment where youth feel safe to have voice and openly share ideas. Remember to also account for physical safety issues, including electrical needs, fire exits, and flow of traffic in and out of the room, as related to the work spaces.

Be Prepared

Read through each section of the Facilitator Guide. Remember that strong, upfront planning of the series of activities will allow you to make connections and see continuity that can be shared with the youth.

Settings

Although these activities are suitable for a wide variety of environments, from after school programs to homeschool, it is recommended to conduct them in a space that supports the curriculum and the learning. If a corner of the gym or other shared space is the only place available, provide a visual connection to the science by use of models or visuals that can transported or brought out of storage each time. Move outside when possible and appropriate.

Provide Consistent Expectations of Behavior

Provide opportunities for choice and include the strengths of all youth to enrich student experiences. Model clear communication strategies by talking directly to youth through maintaining eye contact and practicing active listening skills. Provide options for different learning preferences and intelligence types.

Engage Youth

Note when youth are interested—take advantage of their curiosity and catch those "teachable" moments! Invite them to be actively engaged through your contagious enthusiasm and sense of humor. Notice what engages youth and build on that. Give youth opportunities to ask probing questions and share ideas with each other.

Embed Essential Elements

In 4-H, the critical components of a successful learning experience are a sense of Belonging, Independence, Mastery, and Generosity. It is your role, as a facilitator, to provide guidance and support. Give youth opportunities to become leaders, practice citizenship, and develop a sense of independence and belonging, and an ability to master the content.

Develop Engineers

Provide opportunities for youth to 'emulate' engineers. Model the use of scientific and engineering terms, such as "repeated trial" or "prediction," making sure that the definition can be understood in context. Offer youth an opportunity to use tools that scientists and engineers use. Let them share ways in which they are like engineers in everyday life.

Balance Talking with Hands-On Activities

Limit your talking. Interactive mini-lessons, approximately 5–10 minutes long are sufficient to provide core "chunks" of information. 4-H is about learning-through-doing. Alternate instruction with active hands-on learning. Ask yourself: What is absolutely essential to teach if I want youth to understand the concepts? What can they discover on their own?

Youth quotes:

> "Least fun was the talking times when we weren't doing anything. We were just sitting in the classroom."
>
> "I like that we get to learn something different... Coming here we can feel good about what we do."

Evaluation

Provide ongoing feedback and evaluation throughout the project (formative evaluation) and at the end of the project (summative evaluation).

Encourage Career Exploration

Make the connections to careers in the fields of science, engineering, and technology. Make connections with experts in the field and invite them to share their passion for their profession. Utilize experts as a resource for information and current trends and issues.

Be Relevant

Encourage youth to demonstrate application to the real world. Model this by using relevant examples that apply to their daily lives.

Go Further

Encourage youth to explore beyond the activity and take learning into their own hands. Notice when they become emerging experts and give them leadership opportunities.

4-H Essential Elements

This curriculum is designed to engage youth in learning opportunities that promote positive youth development. In 4-H, the critical components of a successful learning experience are a sense of Belonging, Independence, Mastery, and Generosity. Across the curriculum, each of the 4-H Essential Elements (Belonging, Independence, Mastery, and Generosity) are embedded through the learning experience. In this Facilitator's Guide, opportunities are provided to put the Essential Elements into practice. It is your role, as the facilitator, to foster growth of the Essential Elements through the learning experience.

Belonging

Youth need to know they are cared about by others and feel a sense of connection to others in the group. As the facilitator, it is important to provide youth the opportunity to feel physically and emotionally safe while actively participating in a group. In the facilitator's guide, tips are provided on how to create a safe and inclusive environment and how to foster a positive relationship with youth learners. Under the sections in the youth guide titled Learning from Each Other, there are discussion questions that encourage youth to learn from each other, synthesize, and use ideas collaboratively.

Independence

Youth need to know that they are able to influence people and events through decision-making and action. They learn to better understand themselves and become independent thinkers. Throughout this curriculum, youth are given opportunities to reflect, design, and journal their thoughts and responses to the challenges, explorations, and investigations. Youth begin to understand that they are able to act as change agents with confidence and competence as a result of their learning.

Mastery

In order to develop self-confidence youth need to feel and believe they are capable and they must experience success at solving problems and meeting challenges. Youth need the breadth and depth of topics that allow them to pursue their own interests. Through this curriculum, youth are introduced to expert knowledge. In the sections titled Engineering Design with Sue Larson, youth are given an expert perspective that is practical and relevant to their age and explorations. Across the curriculum, youth are encouraged to think and act like engineers and scientists and use tools to examine, experiment, evaluate, and draw their own conclusions.

Generosity

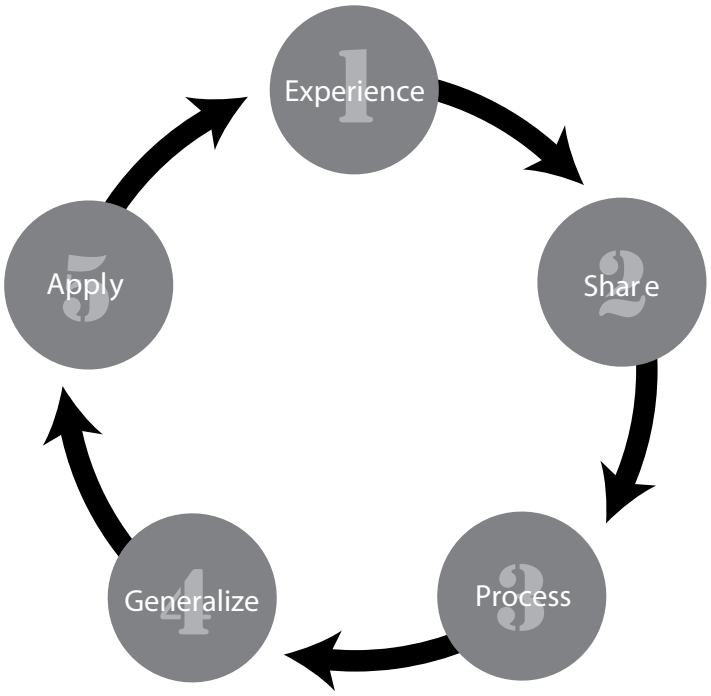
Youth need to feel their lives have meaning and purpose. Through this curriculum, youth examine the use of wind power across the United States. They are encouraged to broaden their perspective, find relevance in it, and bring ideas back to their community. In the sections in the Youth Guide titled Learning from Each Other, they learn to work together as partners or teams and learn to value the contributions of others.

Adapted from 4-H Essential Elements of 4-H Youth Development, Dr. Cathann Kress, 2004.

Experiential Learning Model

The role of the facilitator is to help youth process information on a deeper level and develop strategies for lifelong learning. The model of experiential learning engages youth and encourages learning-by-doing. Experiential learning takes place when a person is involved in an activity, looks back at it critically, determines what was useful or important to remember and uses this information to perform another activity. 4-H youth programs promote life skill development through this type of experiential learning (Joplin, 1995).

Pfeiffer and Jones' experiential learning model is commonly used in 4-H, although other models of experiential learning work well with SET curriculum (Kolb's Learning Model (1975) and Bybee's Learning Cycle (1977). The steps for the five step model are outlined and provided in diagram below:



Pfeiffer, J.W., & Jones, J.E., "Reference Guide to Handbooks and Annuals" © 1983 John Wiley & Sons, Inc. Reprinted with permission of John Wiley & Sons, Inc.

Experience – Youth perform the activity before being told or shown how.

Share – Youth describe the experience and their reaction.

Process – Youth discuss what was most important about what they did.

Generalize – Youth relate the project and life skill practiced to their own everyday experiences.

Apply – Youth share how they will use the project and life skill practiced in other parts of their lives.