Lesson 11	How Do You Build a Music Box?

Suggested Time	One 60-minute session
Lesson Overview	Students will build and program a LEGO music box to be controlled by the motion or proximity sensor. Students will program the music box to make a LEGO person dance to music, using the motor and music blocks. In doing so, they will explore the WeDo programming language. They will learn how to program with motor speeds, wait statements, sensor blocks and loops. - Class discussion of different building methods. - Building of LEGO music box. - Overview of programming the music box with the motion and proximity sensors. - Exploration of loops, wait statements, and motor speeds. - Recording design and test results in Engineering Journal.
Learning Objectives	**By the end of this lesson, students will be able to:** - Define WeDo programming terms. - Be familiar with the WeDo programming language. - Define engineering design as the process of creating solutions to human problems through creativity and the application of math and science knowledge.
Teacher Background	**Introduction to Programming** Start Block: This is the initiation of the program. This is needed to make the program go or commence. Wait Statements: This is used to stall the program in the state that it is currently in. This activity will use the wait statement to keep the motor running for a specific amount of time. Power Levels: When the motor is running, different levels of power, that relate to motor speed can be selected. The higher power level relates to a higher speed. Motor "This Way" or "That Way": The direction of the motor is controlled by the direction of the arrow on the motor programming block. The best way for students to determine

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the forward direction is to test it.

Loop:
Loops are used to repeat a section of programming. This is useful in the acceleration and deceleration challenge in that it repeats the motor forward code, but adds or subtracts to the speed for each loop.

Tilt Sensor:
Depending on the direction of the tilt sensor, you can have the program go in a different direction. To do this, a loop must be created to check the orientation of the sensor and then a decision statement in the form of a message.

Proximity Sensor:
If something is in front of the proximity sensor, it will register on the computer as a certain distance. This can be viewed in the WeDo programming window. Each distance has a corresponding value which can be referenced in programming to tell if the music box is open.

Engineering Design
Engineers typically work together to solve the problems that face society. Engineering design is the process of creating solutions to human problems through creativity and the application of math and science knowledge. The basic steps within the design process include:

   i.   **Identifying a problem** –
         Observing a problem and seeing a need for a solution.
   ii.   **Researching possible solutions** –
         Coming up with ideas to address the problem.
   iii. **Picking the best solution** –
         Determining which idea best addresses the problem. This decision may involve monetary, practicality, material, and property concerns.
   iv.   **Building a prototype** –
         Build a working model of the chosen design
   v.   **Testing the prototype** –
         Be sure the working model solves the problem and holds up to any important material property tests.
   vi.   **Repeating any steps needed to improve the design** –
         The engineering design process is not always a step-by-step process, as engineers often repeat steps or go back and forth between the other five steps.

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Vocabulary	**Engineering –** the process of creating solutions to human problems through creativity and the application of math and science knowledge.
	Start Block – the start block is used to begin or start the program.
	Speed – the distance traveled over a specific time. V = d/t
	Motor Statement – turn the motor on in a specific direction. Other motor commands include: Motor On For Block, Motor Power Block, and Motor Off Block.
	Power Level – the power level is the speed at which the motor will spin. This is used with the Motor Power Block
	Wait Statement – this causes the program to continue in its current state until a specified time has elapsed.
	Loop Statement – this repeats a section of code. Use this when you are going to need to do the same thing over and over again.
	Add or Subtract Block – add or subtract numbers to the current display number. This is useful when increasing or decreasing power levels or changing wait statement times.
	Tilt Block – this is used to base a decision statement on the direction of the tilt sensor.
	Motion Sensor Input – this block references the value of the motion or proximity sensor. This can be used to tell how close you are to an object.
	Play Sound Block – this block can be used to play music or sounds on the computer. Different numbers represent different sounds.
Materials	**For each student** - Engineer's Journal Part 1 **For each student pair** - WeDo kit **For the class** - Handout with program terminology of the programming blocks.

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Start Block

Start On Key Press Block

Start On Message Block

Motor This Way Block

Motor That Way Block

Motor Power Block

Motor On For Block

Motor Off Block

Play Sound Block

Display Block

Add to Display Block

Subtract from Display Block

Multiply by Display Block

Divide by Display Block

Display Background Block

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Send Message Block

Wait For Block

Repeat Block

ABC   Text Input

123   Number Input

Random Input

Record   Stop   Play

Motion Sensor Input

Tilt Sensor Input

Tilt Up

Tilt Down

Tilt This Way

Tilt That Way

Any Tilt

Sound Sensor Input

Display Input

Bubble

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Preparation	- Distribute Engineering Journals - Prepare an example program for the tilt sensor
Instructions for Teachers	**Music Box**

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1. Begin with a class discussion about programming and sensors. Explain the difference between the tilt and motion sensors. The tilt sensor can be used to determine the orientation or position of the music box lid. The motion sensor can be used to determine how far open the music box lid is from where it started.
2. Show students the basics of programming. It would be helpful to do this on a projector with the students. If this is not possible, show the students before they get on the computer. Make sure students understand the terms of the WeDo programming language. Also, clarify any questions they may have.
3. Tell the students that they will be building and programming a LEGO music box that can be controlled by either the tilt or motion sensor. The music box must make a LEGO person dance to music when it is opened.
4. Allow 15 minutes for students to build a music box. Allow students the choice of using the tilt or motion sensor. Give them advice as to where to place the sensor on their music box.
5. Allow 20 minutes for students to program the music box. Answer any questions they may have while programming. When students are ready, have them demonstrate this and record their program in their Engineering Journals.
6. Gather students to discuss what they learned. Make sure to point out any problems that students ran into while programming their
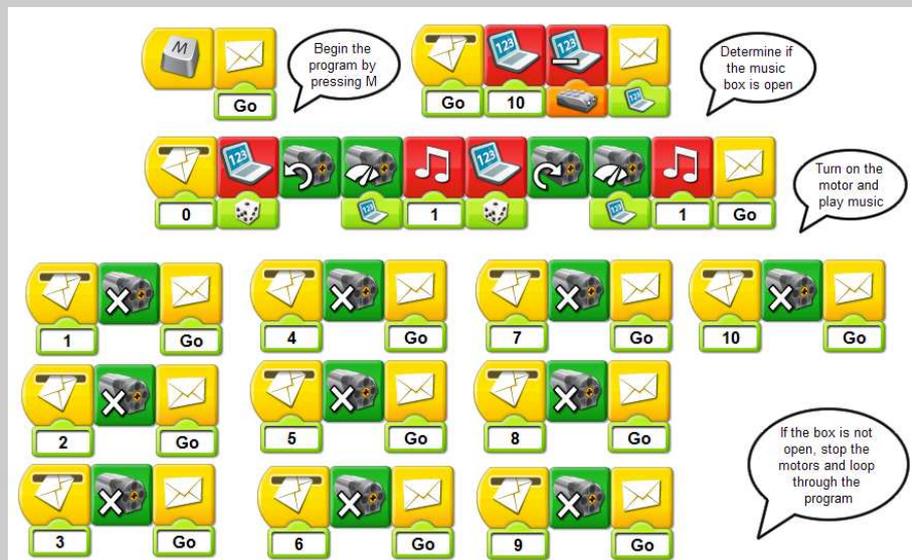
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music boxes. Demonstrate your music box with the tilt sensor and then the motion sensor. Also display your program for the class to see.

The program will only work if the tilt sensor is in a certain orientation. If the tilt sensor is in position, the motors will turn in time with the music.

The display begins with a value of 10 (the motion sensor has a range from 0-10). The value of the motion sensor is subtracted from 10 and a message with that value is sent out. If the message equals 0, then the motion sensor is registering an open music box. This will make the LEGO person dance to the music. Otherwise, nothing will happen.