LITTLEBITS LESSON

Create Your Droid™

TEACHER NAME: [name of teacher]
CLASS/PERIOD: [insert class or period title]

LESSON OVERVIEW

Students build a Droid following the directions contained on the app.

LESSON TAGS

GRADE LEVEL	SUBJECTS	DIFFICULTY	DURATION
Elementary, Middle	STEM, engineering	Beginner	1 x 50 minute class period

SUPPLIES

BITS	ACCESSORIES	OTHER MATERIALS	TOOLS USED
Droid Inventor Kit (1 kit per 2 to 3 students)	littleBits Droid Inventor app One smartphone per group (Android devices above OS version 4.4.2+ with Bluetooth or iOS version 10.0 and up, iPhone 5 and up)		

DESCRIPTION

LESSON OUTLINE	Intro: Introduce students to the littleBits Droid Inventor Kit, and if necessary, establish classroom norms for how to use littleBits. Create: Students follow the directions contained on the littleBits Droid Inventor app to build the Droid. Play: Students get to drive their Droid around Remix (optional): Students complete another mission contained in the Droid Inventor app. Share: Students share out what they like and what they found challenging while building the Droid.
LESSON OBJECTIVES	Students will build a Droid with the littleBits Droid Inventor Kit by following instructions on the app.
ASSESSMENT STRATEGIES	Students will have a completed Droid for use in future lessons.

STANDARDS

VOCABULARY

Droid

RESOURCES

TIPS & TRICKS	It is highly recommended that teachers go through the process of building the Droid before doing it with students. The app has very clear directions but you will be able to help students much quicker if you have done it yourself first.

PACING

One or two 50-minute periods - it takes most of a period to build the Droid. If your students are new to littleBits, this lesson will probably take two periods. If they are experienced, they will likely finish in one.

INSTRUCTIONAL STEPS

STEP 1: SETUP

Duration: varied

Before doing this lesson you will need to consider what devices will be available for your students. Will they use their own smartphones? If you are using school-issued devices, it will save time later to install the app before the lesson. If you are going to have students use their own smartphones, you will need to make sure they have those devices in class and have the ability to install apps on them. One device is needed per group.

Also consider how your littleBits Droid Inventor Kits will be stored. Will they stay in their original box? Do you have alternate storage available? Some of the Bits in the kit are specific to the Droid so will not want to mix those up with any other Bits you may have. If you are doing the other lessons in this series, they start with a completed Droid. It is simplest if the Droids can stay built and not need to be disassembled.

NOTES

Make sure, for whatever device you use, that you and/or the students have the ability to install the app. Contact your IT department in advance if using school devices (see Accessories above for requirements). Students will not be able to build the Droid without access to the app.

Currently, the app is supported on iPhone and Android only. However, it will work on iPads, but the app will not be scaled to the size of the screen.

STEP 2: INTRODUCE

Duration: 10 minutes

Break students in teams of 2-3. If students don't know that they will be working with the littleBits Droid Inventor Kit, this is a great opportunity for some theatrics. The unveiling and unboxing is a great way to engage the students from the start.

Provide each group with a littleBits Droid Inventor Kit and a smartphone. Explain that today, they will be building their own Droid.

Before allowing students to open the kits, make sure they understand that Bits are tools, not toys. Optionally, for groups new to littleBits or younger students, discuss and agree upon a CCC (Community Code of Conduct).

- As a group, come up with 4-5 rules that you all agree on to have a fun and productive learning experience (e.g. ask 3 before me, give constructive criticism, one voice, tools not toys, etc.).
- Write down ideas on the board or a poster; post it in a visible location.
- Once you have a good list, ask everyone to give you a thumbs up high as a sign that they agree to follow the community code.

- Once you have a good list, ask everyone to give you a thumbs up high as a sign that they agree to follow the community code

NOTES

It will likely take most of a 50-minute period to build the Droid. If your students are new to littleBits it is important to establish classroom norms for using the Bits before letting them have the kit. In this case, you will probably need to spend two periods introducing the Bits and building the Droid.

STEP 3: CREATE

Duration: 30+ minutes

If students are using their personal smartphones, you will now need to help them get the app installed. If using a device that already has the app, you can move on.

Have students work through in their groups to construct the Droid. The app has videos and very clear instructions that students should follow at their own pace. Groups should be allowed to move at their own pace. Circulate around the room to help any teams that are having trouble.

The app will have them work through these steps:

1. **Control Hub -** Students connect power to the control hub Bit and generate a Droid sound. Students then connect their device to the control hub Bit and can play a variety of sounds.
2. **Driving Circuit -** Students build the rest of the components needed to get the Droid to drive. They attach two motors and can then control those motors. At this phase, it is still not a Droid; they are still working on building the internal structure.
3. **Internal Structure -** Students finish the internal structure. When they finish they will be able to

drive it, but it will not have the Droid shell.

4. **Droid Shell -** Students put the plastic shell around the internal structure to make it look like a Droid.

NOTES

30 minutes is the minimum amount of time it will take students to build the Droid. The amount of time will vary significantly depending on your students' experience with littleBits and whether you need to install the app. Also, there are numerous opportunities for students to play with their Droid while they are building. While you do not want to take away the fun, if you notice students spending an inordinate amount of time playing around while building, encourage them to keep moving. They will be able to drive their Droid when complete.

STEP 4: PLAY

Duration: 5 to 10 minutes

Once students have completed the Droid Shell mission, they can drive their Droid around.

NOTES

There are numerous other missions on the littleBits Droid Inventor app that students may be tempted to try. You should decide ahead of time if you want students try them. Consider how much class time students will have with the Droid. If you are using the second lesson in this series, students will be doing the obstacle course mission in class.

STEP 5: REMIX

Duration: variable

If any groups finish with time remaining, students can try another mission in the app. Lesson 2 uses the obstacle course mission as a jumping off point, so if you intend to do that, you should steer students away from working on that one. You can direct them to the Secret Message mission. This will allow students to record and send messages using their device.

NOTES

If you are trying to have the students assemble the Droid in a single period, students will not likely have any significant time to get into other missions. If you spread out the build over two periods, you will likely find that some teams finish with time remaining.

STEP 6: SHARE

Duration: 5 to 10 minutes

Have volunteers share what they liked about the Droid, any challenges they faced, and if they have any ideas for something they'd like to try with the Droid in the future.

STEP 7: CLOSE

Duration: 5 minutes

If you are doing the other lessons in this series, students will need a built Droid. Find a place where students can store their Droid intact.

LITTLEBITS LESSON

Droid™ Races

TEACHER NAME: [name of teacher]
CLASS/PERIOD: [insert class or period title]

LESSON OVERVIEW

The lesson begins by holding a Droid race through student-created obstacle course. Students will familiarize themselves with the controls of the Droid. Students record and analyze the race results using age appropriate statistical techniques. Students then hold a 'blindfolded' Droid race where the driver cannot see the Droid and must rely on the directions given by teammates. The lesson closes with a discussion of importance of iterative improvement.

Essential Questions:

- How do our Droids controls work?
- How can we improve our Droid's performance in a race?
- How can we communicate effectively to describe a set of actions?

LESSON TAGS

GRADE LEVEL	SUBJECTS	DIFFICULTY	DURATION
Elementary or Middle	Engineering with math infusion	Intermediate	2-3 x 50-minute class periods

PREREQUISITE KNOWLEDGE

Students should have assembled the Droid either using the first lesson or following directions on the app.

SUPPLIES

BITS	ACCESSORIES	OTHER MATERIALS	TOOLS USED
littleBits Droid Inventor Kits	littleBits Droid Inventor app One smartphone per group (Android devices above OS version 4.4.2+ with Bluetooth or iOS version 10.0 and up, iPhone 5 and up)	Various materials to serve as obstacles: -cups -paper towel rolls -paper -tape -random objects at hand	

DESCRIPTION

LESSON OUTLINE

Intro: Lay out the obstacle course project. Make sure students understand what they need to do.

Create: Students build and test their own obstacle course.

Play: Students test out each other's obstacle courses keeping time. Students can mathematically analyze the race results.

Remix: Students do another race, this time with the driver blindfolded. The teammates who can see need to guide the verbally guide the driver to get the Droid through the courses.

Share: Students discuss successes and challenges from the lesson.

Extension: Students give written directions for the blindfolded operator challenge.

LESSON OBJECTIVES

Students will analyze data collected by racing a Droid through an obstacle course.
Students will understand engineering as an iterative process.
Students will understand the role that sensors play in robotics.

	Students will perform statistical analysis of race data.
ASSESSMENT	Collect student made statistical analysis.
STRATEGIES	Teacher observation and discussion.

STANDARDS

CCSS Math
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).

5.MD.B.2 - Make a line plot to display a data set of measurements in fractions of a unit (1/2, 1/4, 1/8).

6.SP.A.1 - Recognize a statistical question as one that anticipates variability in the data related to the question and accounts for it in the answers.

6.SP.A.2 - Understand that a set of data collected to answer a statistical question has a distribution which can be described by its center, spread, and overall shape.

6.SP.A.3 - Recognize that a measure of center for a numerical data set summarizes all of its values with a single number, while a measure of variation describes how its values vary with a single number.

6.SP.B.4 - Display numerical data in plots on a number line, including dot plots, histograms, and box plots.

6.SP.B.5 - Summarize numerical data sets in relation to their context

NGSS

MS-ETS1-4 - Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

3-5-ETS1-3 - Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

VOCABULARY

Age appropriate statistical terms. Generally for 6th grade or above

- Measures of Center - mean, median
- Measures of Variability - range, interquartile range, mean absolute deviation
- Statistical Displays - box plot, histogram, dot plot

Iteration
Sensor
CPU

RESOURCES

ATTACHMENTS

TIPS & TRICKS	The pacing listed is very tentative. The lesson can take much more time if you opt to do more with statistics or it can be short if you do only the basic challenge.
PACING	15 minutes set up before the lesson Day 1 – Introduce, Create, Play Day 2 – Remix, Share, Close Day 3 – Extension (optional)

INSTRUCTIONAL STEPS

STEP 1: SETUP

Duration: 15 minutes before the lesson

Collect various material that students can use as obstacles for their Droid. Nothing specific is required. Suggestions include: Plastic cups, paper towel rolls, paper, tape, cones from gym class, or pretty much any random thing you have around. Students could even set up a maze on the floor with masking tape.

NOTES

It is assumed that you have at least two Droids and that students are working in groups of two or three

STEP 2: INTRODUCE

Duration: 10 minutes

Students should have built the Droid in Lesson 1. Explain to students that it is time to field test their new creation. They will be designing an obstacle course for the Droid to maneuver through. Each team (pair) will design a simple course and practice driving their Droid through.

NOTES

Have a variety of obstacles available for students to choose from.

STEP 3: CREATE

Duration: 10 minutes

Students build the obstacle course and test it with their Droid. They should find the minimum time possible to complete their own course. They should practice until they feel they have the best possible time.

NOTES

Students may take a long time building their courses. If you intend to do data analysis with the race results, you will need to make sure students move through this step rather quickly. The obstacle courses do not need to be overly intricate. In fact, slightly easier courses are preferable for the blindfolded portion of the lesson.

STEP 4: PLAY

Duration: 30 minutes

Students try each other's courses. At this point in the lesson you can include some data analysis. Students can record how long it takes other teams to do their course. Depending on the time you have available, you could ask the question "How much better do we get on our second try?" Students would record two trials and then use data analysis techniques that are age appropriate to answer the question.

NOTES

Depending on the amount of time here there are plenty of ways to incorporate basic statistical analysis. With younger students you could just look at the varying times and talk about why everyone gets different times even though they have the same Droid. With upper elementary students you could create a basic plot (bar graph, dot plot, etc.). With middle or high school students you could do more complex data analysis involving measures of center and spread and more sophisticated graphs such as box plots or histograms.

For example:

- Grades 4 and 5 can make a line plot (CCSS 4.MD.B.4 and CCSS 5.MD.B.2) of the results.
- Grade 6 and higher can do a more thorough analysis:
    - You can discuss that due to the variation in race times, statistics are an appropriate tool (CCSS 6.SP.A.1). The results of the races can be summarized graphically (CCSS 6.SP.B.4) using dot plots, histograms, or box plots. The results can also be summarized numerically (CCSS 6.SP.B.5) by using measures of center (mean, median) and spread (range, mean absolute deviation). Before beginning, you can hold a discussion with your class about what they know about statistical analysis. Depending on when you do this lesson, students may not have covered the required content. In this case, doing a more basic analysis would be prudent. If students already are familiar with more advanced statistics, then you can have them think about which method for analyzing this data would yield the most useful results.

Lastly, you should decide how formal you would like the analysis to be. You can have students do a formal write up using word processing and spreadsheet tools to complete their statistical analysis. Alternately, you can have students complete the work by hand. You may even have students do the analysis very informally. A more detailed, formal analysis will obviously take time. If you go that route you will likely need to spend a good deal more than the listed 30 minutes.

STEP 5: REMIX

Duration: 40 minutes

After students have completed their first run-through of the obstacle course, announce to students that you have a new challenge for them. They will make race the courses again, BUT, this time the driver of the Droid won't be able to see the course or the Droid. They will have to drive the Droid by verbal directions from their teammates. The teammates will act like the Droid sensors and give commands to the Droid's CPU (the operator with the app) about what they see.

If your students made very complicated courses for the first Droid race, you may want to have them

make new, simpler courses. Alternately, you can have students use the same courses thus giving you an opportunity to compare the statistics from first Droid races to the blindfolded Droid races.

Once each team has a course set up, they will repeat the time trials. Have teams try each other's courses. However, the driver of the Droid should not be able to see the course. Have the drivers move in such a way to keep their back to the course. Or blindfold them if you want a real challenge. The partners not driving the robot should give verbal directions to the driver ("move forward," "stop," "turn right," etc.) in an attempt to get the Droid to move through the course. The driver should not be allowed to see the Droid at any point.

You can have teams pick who is the driver and who is the navigator or you can assign roles. This depends on dynamics of your student groups.

You will likely find that teams that communicate precisely will do the best at this challenge. If you hear any teams using particularly precise language, you may want to highlight so other teams can develop.

NOTES

If you want, you could do more data analysis here. If you opted to keep the courses the same, you can compare the statistics collected from the first round of the races to the blindfolded races.

STEP 6: SHARE

Duration: 10 minutes

Have students share challenges they faced during this lesson. Discuss with students the importance of precision during the blind driver challenge. You can discuss how if the Droid were real, the coders who programmed it would need to have been very precise in translating sensor input into actions. You can discuss how computers are really "dumb" in that they cannot think on their own. They need to be told what to do very precisely. Small errors in code (bugs) produce results that don't work.

You can also have a discussion about improvement by iteration. If you have multiple courses set up, students will very likely be better communicators in latter races than the first ones they try. You can highlight how incremental improvements are very important and it isn't expected that engineers have it perfect the first time.

STEP 7: CLOSE

Duration: 5 mintues

Put Droids and materials away

NOTES

Keep Droids assembled if continuing to lesson 3.

STEP 8: EXTENSIONS

Duration: variable

A very challenging extension would have students give written instructions to complete a blind driver race. One student takes the Droid and maneuvers through the obstacle course making careful notes about what being done on the controls. (something like – forward for 3 seconds – right for 2 seconds – forward for 8 seconds, etc.). These written directions are given to the driver who cannot see the course. This driver attempts to execute the course from the directions. The writer can watch and note if the driver is making errors, if the language was unclear, or if the writer made an error. If the Droid did not successfully navigate the course, the writer can give the driver a new set of directions with corrected errors, more precise language, or notes about errors to avoid.

LITTLEBITS LESSON

Droid™ Designer

TEACHER NAME: [name of teacher]
CLASS/PERIOD: [insert class or period title]

LESSON OVERVIEW

Students will take the role of Droid Attachment Designers and create an attachment for a character in the Star Wars universe.

Essential Questions:

- What can you add to a Droid to make it useful for a Star Wars character?

LESSON TAGS

GRADE LEVEL	SUBJECTS	DIFFICULTY	DURATION
Elementary, middle	STEM, engineering	Beginner	4 or more 50 minute periods

PREREQUISITE KNOWLEDGE

Students should have assembled the Droid either using the first lesson or following directions on the app.

SUPPLIES

BITS	ACCESSORIES	OTHER MATERIALS	TOOLS USED
littleBits Droid Inventor	littleBits Droid Inventor	Various craft materials	General craft tools

Kits Other Bits you have (not required)	app One smartphone per group (Android devices above OS version 4.4.2+ with Bluetooth or iOS version 10.0 and up, iPhone 5 and up) Laptops or tablets with internet access (preferably one for each student, but one per group can work)	-paper -markers -colored pencils -tape -glue	-scissors -ruler or tape measure

DESCRIPTION

LESSON OUTLINE

Intro: Students learn that they will be designing Droid attachments.

Create: Students learn about a Star Wars character and brainstorm attachement ideas. They sketch and explain their ideas to partners. Then as a group, they prototype the group's favorite idea.

Play / Remix: Students test out their attachment idea. They refine or change as needed.

Share: Students present their attachment to the class in a mock sales pitch.

Extension (optional): Students design an attachment that they would want if they owned a Droid.

LESSON OBJECTIVES

Students will design and prototype a physical attachment for a Droid that meets a customer's needs. Students will present their creation in a mock sales pitch.

ASSESSMENT STRATEGIES

Create a rubric for the final presentations to highlight criteria you find important. Use the littleBits Invention Log Checklist (page 18 of document) as a starting point.

STANDARDS

NGSS

3-5-ETS1-1 - 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-ETS1-2 - Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
3-5-ETS1-3 - Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

MS-ETS1-1 - Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
MS-ETS1-2 - Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
MS-ETS1-3 - Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
MS-ETS1-4 - Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

VOCABULARY

Market research
Sales pitch

RESOURCES

ATTACHMENTS	Research and brainstorming sheet (bottom of lesson)
TIPS & TRICKS	Informally pre-assess your students' familiarity with the Star Wars universe before the lesson to inform how well they will know characters.

PACING

Day 1 & 2: Intro and Create
Day 3: Play and Remix
Day 4: Share and Close

INSTRUCTIONAL STEPS

STEP 1: SETUP

Duration: 10 minutes

Gather various arts and crafts materials.

NOTES

The more varied materials you have, the better. This lesson is all about being creative and building something new. If you have other Bits, they can be used as well.

STEP 2: INTRODUCE

Duration: 10 minutes

Explain to students that today they are going to be Droid designers. They have been hired by a company that produces accessories for Droids. They have some new customers that are interested in buying some cool new attachments to put on their Droid. Students will need to design, prototype and present an attachement for their customer.

Find a list of Star Wars characters (such as http://www.starwars.com/databank or https://en.wikipedia.org/wiki/List_of_Star_Wars_characters or http://www.rollingstone.com/movies/lists/50-best-star-wars-characters-20151203/aunt-beru-20151203.)
You can either narrow down the large list and give students some options, allow them to pick any character, or assign them a specific character depending on the amount of freedom you wish to allow. A curated list is probably the best choice as students will have some freedom without being overwhelmed with options.

Once students have their character, explain that they will need to create a sales pitch where they present a Droid attachment that this character will just love. Explain that they will need to do some market

research and learn what this character may want. They should then sketch out their design, and last, they should prototype what this design will look like.

For example, if a student picks Jabba the Hutt, then the student may learn that he lives in a throne room with all sorts of creatures. Perhaps Jabba would like to clean up the place. The students would then design an attachment that would help the Droid clean.

NOTES

It is probably best if students choose a more well known character than one of the more obscure ones. It will be much easier to find out information about the character, particularly for students who do not know Star Wars.

STEP 3: CREATE

Duration: 40 minutes day 1, 50 minutes day 2

Day 1:

Students receive or choose a Star Wars character and learn about them. They research the character using the websites provided above and other sources to learn about their character's personality, where they live, what they do, etc. Students brainstorm attachments that this character may find helpful.

After brainstorming many ideas, they choose their favorite. They draw a sketch of their favorite attachment.

There is a sample research and brainstorming worksheet included on the last two pages of this document.

Once students have had a chance to think independently, put them into groups of 2 or 3. Each student in the group presents their character and idea to their partners. The group then decides on a character and idea that they wish to build a physical prototype for. If groups are having trouble agreeing, have them make a list of pros and cons for each choice. Make sure they are picking a creative idea that is actually possible to prototype.

Students should compile a list of materials they wish to use for their prototype. Let students know what materials are available to them. If the group wishes to use a material not available, then they will need to bring it in or make an alternate choice

NOTE: if you do not have enough devices with internet access for each student to have their own, you will need to modify the process. Have students work in teams to pick a character first and research as a team. Students can then brainstorm independently. After they have had time think on their own, the groups come back together and pick their favorite idea to prototype.

Day 2:

Students, working in groups assigned previously, build a prototype of their Droid attachment. They can use craft materials you provide or materials brought from home. If you have other Bits, this would be a good opportunity to allow students to prototype with them. It is not necessary, however, to have more Bits as students can prototype out of any sort of craft material.

NOTES

Students who are unfamiliar with Star Wars will find it difficult to know what to do because they won't know the character. Having a few ideas to get them started would be helpful.

STEP 4: PLAY

Duration: 15 minutes

Students run their Droid with the attachment and make sure it works the way they had hoped.

NOTES

The Play and Remix portions of this lesson are concurrent. Students work on building their attachment and refining as needed on day 3.

STEP 5: REMIX

Duration: 35 minutes

Students can change, redo, or start over if the attachment they build isn't to their liking.

STEP 6: SHARE

Duration: 40 minutes

Students present their Droid attachment to the class. You can pretend that this is a sales pitch and have the students present as if they are trying to sell their creation to the character.

NOTES

Depending on the amount of time you have, you could have students do very detailed presentations. That is, make slides and treat it more like a real sales pitch. Alternately, you could just have the students present informally and treat this more like a share session. If you go with detailed presentations, students will likely need an extra day to prepare.

STEP 7: CLOSE

Duration: 10 mintues

You, the teacher, could pretend that you are the characters and say whether you would buy each attachment presented. That is, for groups that made a convincing sales pitch, you would buy the attachment. For groups that did not, you could give them some feedback.

Take the attachments off the Droids and clean up.

STEP 8: EXTENSIONS

Duration: varied

You can have students imagine they live in a galaxy far, far, away and ask them what they would want their Droid to do. They can design a Droid attachment that they would want.

Droid Designer

Name _____

What character are you designing for?

Describe your character's personality? Where do they live? What do they do?

Brainstorm some Droid attachments.

Imagine your character owned a Droid. What might they want their Droid to do? What attachment would your Droid need to accomplish this task? Write as many ideas as you can.

Pick your favorite idea.

What is your favorite Droid attachment? Why did you pick this idea?

Sketch your favorite idea.

Draw out how you imagine it would look.

What materials do you need?

List out what materials you would want to prototype this attachment.