

3Doodler Classroom Basics: Part 3

Exploring Materials

Suitable Ages:

Suitable for ages 14+

Skill Level:

Basic

Materials Required:

- 3Doodler 2.0: 1 for each student (recommended; can also deploy one for every two students)
- 3Doodler ABS strands: 1 strand per 3Doodler
- 3Doodler PLA strands: 1 strand per 3Doodler
- 3Doodler FLEXY strands: 1 strand per 3Doodler
- Masking tape

Duration:

~45 minutes

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Objective

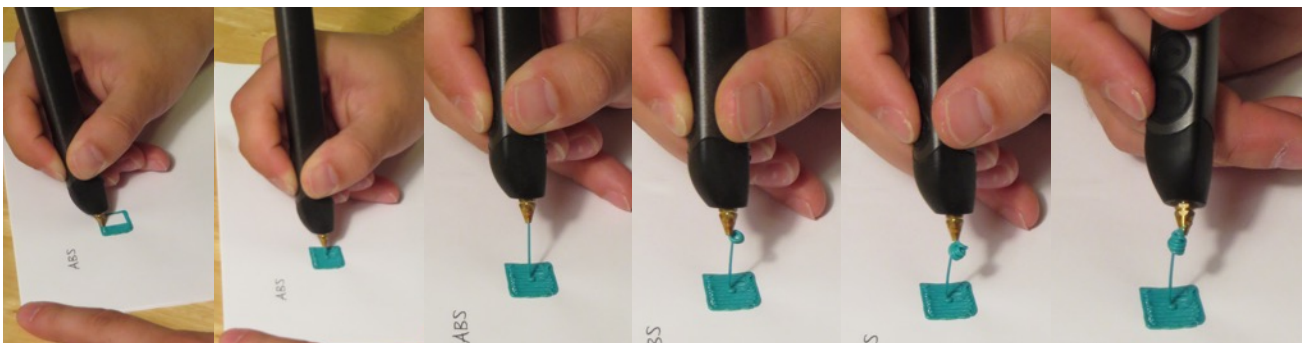
Following this lesson, students will be able to identify the different types of materials that are available for the 3Doodler and their unique properties and uses, along with the proper temperature settings for each. Additionally, students will successfully insert, extrude, and reverse a strand of ABS, PLA, and FLEXY.

Warm-up

Introduce ABS, PLA, and FLEXY using the Materials Guide (included on page 7). Have students take notes on the provided **Materials Guide Worksheet** on page 9. With each material (ABS, PLA, FLEXY), demonstrate the following so that students can later do the same:

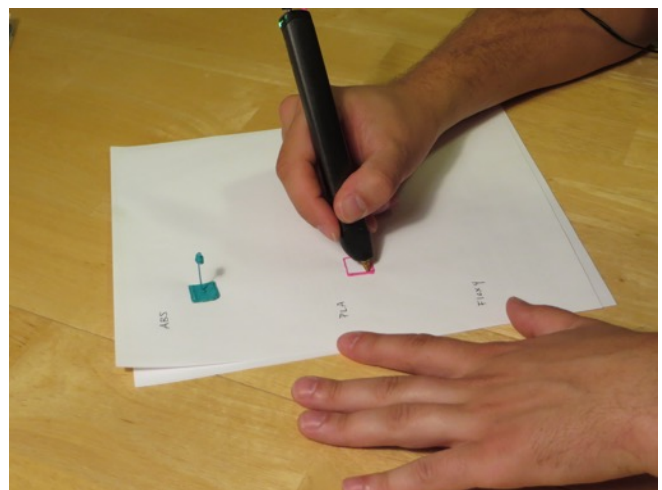
1. tracing and then filling in a stencil
2. drawing vertically into the air from the center of the filled-in section
3. adding a small bead of plastic to the end of the Doodle with each material.

Imagine the finished Doodle as a tiny balloon with its string tied to the ground.



Activity

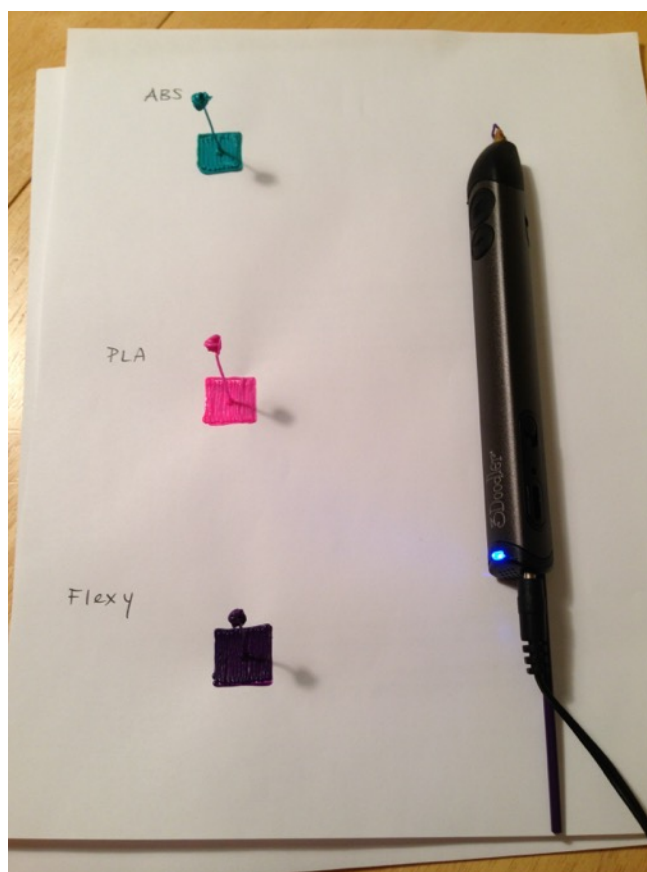
Each student will be provided with a strand of ABS, PLA, and FLEXY. Starting with ABS, students will turn the 3Doodler to the proper heat setting and using the provided handout, trace the square template, fill it in, draw a vertical line up from the center, and finally add a bead of plastic to the top (following the same steps as in the **Warm-up** demonstration).



Repeat these steps, all together as a class, continuing with FLEXY and then PLA. Upon completion, have the students discuss as a class what was different about each material.

Sequence

1. Have students take notes on the provided Materials Guide hand-out outlining ABS, PLA, and FLEXY (5 min.)
2. Demonstrate what each student will be doing with each material, resulting in a tiny balloon in each of the three materials (5 min.)
3. Each student will get a strand of ABS, PLA, and FLEXY and as a class, beginning with ABS, then FLEXY, then PLA, create their own tiny balloons following the template and directions (25 min.)
4. When all three tiny balloons are complete, have the students investigate their creations and see how the finished products vary (5 min.); they should discuss appearance and finish, rigidity, breakability, etc.
5. Exit reflection. Go around the room and have every student provide a scenario in which they would use a particular material and why. Have students write down 2 ideas for each material that they think are best (5 min.)



Striving Students

Ensuring that the class stays together through all steps will help striving students to stay on task and not fall behind.

Accelerated Students

Following the directions is great, but there's a lot more going on here. Encourage accelerated students to consider the subtle differences in the materials and how they may interact with each other or other materials. These students may benefit from a more thorough exploration of the properties of each material as described in the 3Doodler materials comparison (the3Doodler.com/3doodler-plastics-head-to-head/).

Evaluation Strategies

Students will be graded according to a rubric on their attentiveness and participation as well as filling out the Materials Guide Worksheet and the creation of a small balloon shape in each type of material. Making sure that every student participates is very important to this lesson, there are many possible uses for these materials, every student should have the opportunity to provide an answer.

Evaluation Rubric

	4	3	2	1
Participation	Students raise their hands to ask and answer pertinent questions. Follow directions. Stay on task. Every student will be called upon in this lesson, must provide acceptable answer.	Students raise their hands to ask and answer pertinent questions. Follow directions. Provides thoughtful answer.	Students answer when called upon. Follow directions.	Students fail to engage in classroom discussion. Failure to follow directions/stay on task.
Attentiveness	Students are following along and paying close attention at all times.	Students are following along with the lesson.	Students need to be reminded of instruction due to lack of attention.	Students are not following along/ paying attention.
Completion of a tiny balloon in ABS, PLA, and FLEXY	A successful filled in square with a free-standing vertical line, with a small ball on top. One in each material.	Created something in each material, but not quite a tiny balloon.	Something created in at least two of the materials.	Failure to extrude in all three materials.
Exit Reflection	Provides a thoughtful idea for a particular use of one of the materials. Active in conversation. Provides thorough list and reasons on hand-out.	Provides an idea for a use of one of the materials. Provides two uses and reasons for each material on hand-out.	Provides an idea for a use of one of the materials. Provides 1 use and reason for each material on hand-out.	Failure to provide an acceptable answer/ fill out hand-out.

Materials Guide Handout

(N.B.: Underlined items appear as blanks on the Materials Guide Worksheet)

3Doodler Pro Tip

When switching from ABS or FLEXY to PLA, i.e. switching from the HI to the LO heat setting, be sure to either reverse out or completely extrude the plastic in the 3Doodler before switching heat settings.

The reason for this is that switching to the lower heat while there is still ABS or FLEXY in the pen will cause the material to cool to the point that it cannot be extruded. This is a common and easily avoidable cause of poor extrusion.

If there is plastic in the 3Doodler when you begin and you are not certain whether it is ABS, PLA or FLEXY, then begin using the pen on the HI temperature setting and extrude at the **slow** speed using the smaller of the two buttons. If you are planning to use PLA, switch the temperature setting to LO once the old material has completely extruded and the PLA begins to emerge from the nozzle. Using different colored strands can help to identify changes between the extruded plastics.

ABS

ABS is made of Acrylonitrile Butadiene Styrene. This is a very common form of plastic found in many household items and is the same plastic that LEGO bricks are made of.

ABS uses the HI heat setting with the 3Doodler (225-250° C / 437-482° F).

It's great for drawing into the air and building structures freehand.

It peels off regular paper easily, and is great for welding plastics together. It can also be used for repairs.

ABS is less rigid and easier to bend than PLA.

Additional notes on ABS:

PLA

PLA is made of Polylactic Acid. Also known as a bioplastic because it is derived from renewable resources, including corn starch. Because of this, PLA is compostable.

PLA uses the LO heat setting on the 3Doodler (190-240° C / 374-464° F) and hardens more slowly than ABS, so though it is harder to draw in the air, you get the benefit of being able to shape your plastic for longer after it has been extruded.

When cooled PLA is very rigid and will usually crack rather than bend. Using a hairdryer or heat gun will remelt items made in PLA and make them pliable again which can be used for all sorts of great results.

If you want your doodle to stay firmly attached to the paper you're using then PLA is the filament to use. It also sticks well to glass and metal. PLA can also be used to doodle on fabrics.

Most exciting about PLA is that it comes in over 40 beautiful colors that have a great glossy finish to them and even include a variety of translucent and metallic colors.

Additional notes on PLA:

FLEXY

FLEXY is a rubberized plastic made of Thermoplastic Polyurethane (TPU) that can be used to make items that can be stretched, twisted, bent, crumpled, folded, and mashed and will return to the shape that you Doodled it in.

FLEXY uses the HI heat setting (225-250° C / 437-482° F), but cools slowly like PLA. Not as good for drawing in the air as ABS, but able to be shaped for longer after being extruded.

It is great for bonding pieces together, especially if they could use a little flex. Awesome for 3Doodling wearables and practical items like a wallet, phone case, or your own watchband!

Additional notes on FLEXY:

Materials Guide Worksheet

Directions: Please fill in the blank with the correct answer.

ABS

ABS is made of _____. This is a very common form of plastic found in many household items and is the same plastic that LEGO bricks are made of.

ABS uses the ___ heat setting with the 3Doodler (_____).

It's great for drawing into the air and building structures freehand.

It peels off _____ easily, and is great for _____. It can also be used for _____.

ABS is _____ and _____ than _____.

PLA

PLA is made of _____. Also known as a _____ because it is derived from renewable resources, including _____. Because of this, PLA is _____.

PLA uses the ___ heat setting on the 3Doodler (_____) and hardens _____ than ABS, so though it is harder to draw in the air, you get the benefit of being able to shape your plastic for _____ after it has been extruded.

When cooled PLA is very _____ and will usually _____. Using a _____ or heat gun will _____ items made in PLA and make them pliable again which can be used for all sorts of great results.

If you want your doodle to stay firmly attached to the paper you're using then PLA is the filament to use. It also sticks well to _____ and _____. PLA can also be used to doodle on _____.

Most exciting about PLA is that it comes in over 40 beautiful colors that have a great _____ finish to them and even include a variety of translucent and metallic colors.

FLEXY

FLEXY is a rubberized plastic made of _____ that can be used to make items that can be stretched, twisted, bent, crumpled, folded, and mushed and will return to the shape that you Doodled it in.

FLEXY uses the ___ heat setting (_____), but cools slowly like PLA. Not as good for drawing in the air as ABS, but able to be shaped for longer after being extruded.

It is great for bonding pieces together, especially if they could use a little flex. Awesome for 3Doodling _____ and _____ like a _____!

Additional Resources

Tutorial Videos

Please visit the3Doodler.com/videos/#started to find videos demonstrating the skills required for this activity. Individual videos that will be useful include:

- **Inserting Plastic:**
 - YouTube: <https://www.youtube.com/watch?v=ZSmdhZEnMDE>
 - Dropbox: <https://www.dropbox.com/s/3jnmafuve2saqu4/Inserting%20Plastic.mp4?dl=0>
- **The Buttons:**
 - YouTube: <https://www.youtube.com/watch?v=mos2SBukObo>
 - Dropbox: <https://www.dropbox.com/s/cqkozrmhktr3u38/Buttons.mp4?dl=0>
- **Reversing Plastic:**
 - YouTube: <https://www.youtube.com/watch?v=aD84E55mgac>
 - Dropbox: <https://www.dropbox.com/s/mpzxcrky9f5aq41/Reversing%20Plastic.mp4?dl=0>

Additional Inspiration

For additional inspiration and ideas about other simple projects that can be accomplished at this level, check out the following links:

- Stencils and Projects: the3Doodler.com/community/
- Doodles by You: the3Doodler.com/doodles/
- Videos: the3Doodler.com/videos/
 - Getting Started: the3Doodler.com/videos/#started
 - Tips & Tricks: the3Doodler.com/videos/#tips

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More curricular materials are available at the3Doodler.com/education/.

If you have additional ideas for classroom activities or lessons, feel free to reach out to us at education@the3Doodler.com!