# Spinners Workshop Guide

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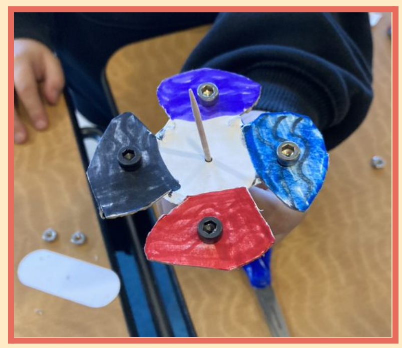
## Disclaimer:

**We implemented this workshop with materials that are not universally available (laser cutting machine, Cricut, nuts + bolts) and understand that many classrooms will not have the same access. We will suggest alternatives where applicable, but feel free to take inspiration from or personalize the lessons!**



**Say the words "fidget spinner" to your class, and you're almost certain to get an impressive reaction. Piggybacking off this, we've built a workshop that will allow your kids to experimentally develop an understanding and intuition regarding friction and angular momentum. They'll learn about the iterative design process, personalize their creations, and of course, have a spin-tastic time!**



## Workshop Requirements

**This workshop can be run in one 90-minute session, or it can be divided into two sessions that take 45 minutes each.**

- **Suggested grades:** Grades 2-5
- **Prep Time:** 1 hour (with laser cutter)
- **Workshop Time:** 90 minutes
- **Required materials:**
    - Paperboard (like cereal box cardboard) OR standard 1-ply cardboard
        - Note that this depends on what materials you have available/ what is easier to cut
    - Scissors (1 per student recommended)
    - Markers (Enough for a table to share)
    - Pencils (Enough for a table to share)
    - Long Reach Hole Punch (1, ideally the instructor can do it for the students because precision is important during this step)
    - #10-24 ¼” bolts and #10-24 nuts
        - OR tape and pennies (no holes needed, may be easier without access to laser cutter, however we prefer nuts and bolts because it is much easier to balance the weight of the spinners without the added difficulty of tape)
    - “The Handle” - (toothpick, glue, and a small round cardboard “base”, designed to hold the spinner in place)
    - Small Washers (that fit around toothpicks) - like these
    - Stopwatches
    - Fabric (only enough for a few square inches per table)
        - ideally something with a noticeable texture like burlap, felt, or velvet

- **Optional Materials:**
    - Worksheets (linked at bottom of page)
        - Instruction sheet - One per pod of tables, given at the start of the workshop
        - Reflections sheet - One per student, given at the end of the workshop

## Learning Goals for Students

- Associate art and creativity with STEM learning
- Gain an intuition for weight distribution, angular momentum, and friction
- Students reach conclusions through exploration and inquiry
- Become comfortable with the iteration process and fabricating new, original designs
- Collaborate with other students to develop teaming skills

## Workshop Preparation/ Fabrication

- **Prefab requirements: We laser cut our cardboard "blanks" and used a cricut to make paper templates for our students. We understand that not every educator will have access to these resources. Our laser cutter spinner templates are here, however they can also be reformatted and printed on standard paper to cut out by hand (potentially even by students as part of the workshop). [LINK TO RESOURCES]**

- Building the "handles"
  - Requires toothpick, hot glue, and round cardboard "base"
  - Poke a hole in the middle of the cardboard "base" and push the toothpick ~ ⅓ of the way through. Hot glue from the bottom (the shorter end) to secure in place. Make sure the cardboard is as flat as possible to prevent wobble.
  - Note that bases are included in laser cut templates for convenience

- Cut circle with holes for weight and friction activity [File]

- Cutting the cardboard "blanks" (aka the rounded cardboard squares that will become the spinner surface) [File]
  - Note that we did this ahead of time but students can also cut directly from the cardboard sheets without preparation.

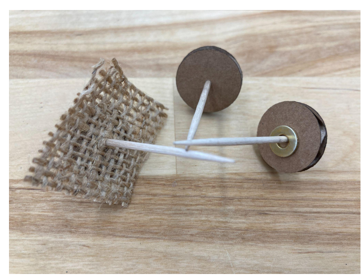
- Cut paper shape templates [File]
  - We provided some shapes the students could trace on their cardboard for inspiration. This is optional but is a helpful stepping stone for students who desire more scaffolding. Of course, students can start with these shape outlines and then modify them however they like.

- ➢ Cut hole placement templates (note that these are different from the previous circles and can be cardboard or paper since they're only used for tracing where the holes for the nuts and bolts will go, not needed if you are substituting for pennies) [File]
  - Printable hand-cut file not provided but given file could be adapted for manual prep - could print the above file onto regular paper and manually hand-cut circle and hole-punch the holes.
- ➢ Note on usage and number of materials:
  - We gave each student ~3 blank cardboard templates. We didn't want to create anxiety about "getting it right the first time", and wanted to normalize failure in the pursuit of success by iteration. On the other hand, we also wanted to encourage thoughtfulness. We had extras prepared for students who wanted more.

## Workshop Instructions

**Testing the Friction of Different Materials** (15 mins)

- ➢ Before your kids arrive, try to have the cardboard blanks, the spinner handle, fabric, and a washer on their table. Pair them off so that during the testing phase, one student can spin their spinner while the other student times it with the stopwatch.
- ➢ Invite the students to place one of the following materials between the handle and the cardboard "blank" spinner at a time:
  - Nothing (aka existing cardboard surfaces)
  - Fabric
  - Washer



- ➢ The students then spin the spinner and use the stopwatch to time how long it takes to come to a complete stop with each of the materials, switching the materials out after three or so tests.
- ➢ Debrief:Through experimentation with the stopwatches and just with the feel of it, students should reach the conclusion that adding a washer between the spinner tool

and spinner gets the best results. They should especially be able to recognize that the fabric slows things down a lot ("that's friction!")

- Allow students to explore with unplanned experimentation as well. Ex: stacking materials, putting the materials on the top vs on the bottom of the spinner, let them naturally play around.
- Discuss in small groups and then as a class why students think different materials cause different results and what attributes might be causing the changes.
- As they experiment, keep asking them these and similar guiding questions to guide them to the right conclusions:
  - Does this one feel harder to spin? Why?
  - If you put more of that same fabric on there, is it going to get even faster or even slower?
  - What if you put the fabric/washer on the top of the spinning surface?

**Adding Weights - Structured (**20 mins**)**

➢ Give each student 4 nuts and 4 bolts (or have them share) and a precut cardboard blank with holes. Note that pennies and tape work as an alternative, but be cautious about allowing them to put a bunch of tape on their spinner (this can also affect weight).

- If needed, prompt them to try different arrangements of these nuts and bolts
  - "Try 4 on one side"
  - "Try 3 on one side, 1 on one side"
- Ask them to qualitatively and quantitatively explain what's happening. They will begin to develop an intuition for what's going on.

➢ Debrief: students understand that adding weights can make the fidget spinner spin longer, but the weights have to be evenly distributed

**Creating Their Own Shapes (**30 mins**)**

- Now students can experiment with shapes. Give them scissors and the paper shape templates. Encourage them to draw it out with pencils first, and allow them to make their own custom shapes or trace (and potentially modify) the templates.

- Ask them to time how long their spinner spins with the stopwatch!

    - This can be recorded on paper and older students can learn how to find the average of their data.

**Adding Weights to Custom Shapes (**30 Mins**)**

- Use the templates with holes to make sure that the weights will be spaced out evenly (this is very important) and use the hole punch to make holes in each of the custom cardboard spinners. Thread the nuts and bolts through like before. Alternatively, pennies could be taped onto the top of the cardboard, which has less of an effect, but doesn't need to be as precise.

**OPTIONAL: Competition (**20 mins, depending on # of kids**)**

- Let them compete with their decorated spinners to see who spins the longest! You can also create categories for longest-spinning spinner, best-designed spinner, best-decorated spinner, etc.

## Suggested Tips for Running this Workshop

- **Physical room set up:**

    - We suggest putting out all of the cardboard on their desks before they show up, but not handing out scissors quite then so they can't immediately start cutting them up

    - We suggest setting the tables up in groups so that students can discuss findings and share inspiration.

    - Take regular breaks to inquire about their learning (i.e. "What kind of cut-out works the best?")

- ➢ **Pairings:**
    - It may work out better to have students work in pairs while making their own spinners as it conserves materials and gives them a partner to bounce ideas off of. Moreover, it allows them to have someone to time how long their spinner spins as well as someone to help them build. We ran these activities with different groups of students, some of whom enjoyed being in pairs and others who preferred doing it alone.
- ➢ **Tips for using handouts.** We've added a few handouts with some level of scaffolding (some written instructions + a table to use when timing the spinners). We recommend that you give them the handout as an option to use as a guide, but do *not* be worried if your students would love to "do-learn" and just fiddle around instead.
- ➢ **Intentional commentary.** Comments such as the following can help students build and recognize STEM-related mindsets and skills
    - "You're expected to get it wrong the first time you do this, so you have multiple circles to try again!"
    - "How can we engineer a (faster/more balanced/longer spinning/_____) spinner?" (Specifically using the word engineer will help them internalize that they're doing *engineering*!)
    - "What are you hoping to improve on this iteration/this time?"

## Connections to Science and Engineering

This workshop was designed to teach the concepts of friction and angular momentum through a fun, hands-on activity that builds upon kids' natural interests in fidget spinners.Using familiar topics like this can allow students to make better observations about the world they live in. If the spinners are not creating that learning experience for students, it may be worth explaining them in other physical ways. For example, when talking about friction, you could explain it with ice skating. "Imagine you are ice skating on ice and all of a sudden the ice turns into grass, what's going to happen?" That can be a way for the students to see how different surfaces contribute to friction, especially how smoother surfaces are better for low friction. Moreover you could say "Imagine you tried to wear your roller skates on ice, what's going to happen". This highlights how the contact area between objects also matters, and the less contact area, the better for low friction.

## Educational Design Principles Used to Create this Workshop

We are Olin College undergraduate engineering students who are practicing the engineering design cycle through the iterative design, development, testing, and improvement of STEM workshops for elementary school students. We began our user research phase by visiting our partner students. We engaged our partner students with standard engineering design challenges as a way to get to know what they like, what motivates them, their fine motor building skills, their teaming skills, etc. This informed our creation of custom workshops for our partner students, which we then improved and tailored to work with a second class of students.

Our work has also been guided by our learnings about some educational design theories/principles. In this section, we provide information about how these educational design theories/principles have been used in the design of our workshop. We hope this will help teachers understand our motivations and therefore be more able to modify our workshops to work better for their students in their unique educational context.

Throughout our design work, we practiced keeping a tight loop between our goals (i.e., our learning objectives related to STEM content, social-emotional learning, and the development of confidence and belonging in STEM) and the activities we designed to achieve these goals.

- Goal #1: To integrate art and creativity into STEM activities
- Arts and the humanities are often placed in a false dichotomy with STEM activities, and we wanted to break that subconscious box that these kids might be building in their minds.
- To do this, we're giving them the opportunity to decorate their spinner and see the way colors blur and shift when the spinner spins. When the spinner spins, it essentially mixes the colors on it, which can create really neat effects — no guidelines here, let your kids experiment!

- Goal #2: To make our activity hands-on
- Although there is a fair amount of theory involved with the STEM curricula, we wanted students to *feel* scientific concepts in their hands to help build a connection between the real world and concepts/definitions they have learned or will learn in science classes.
- To do this, the whole activity is centered around an experimental process that allows them to *see* things like what unbalancing a spinner will do to the amount of time it spins and to *feel* concepts that may be more nebulous, like coefficients of friction.. We hope that this will allow them to more intuitively understand these rather complex concepts when they learn them in a classroom.

- Goal #3: To incorporate kids' lives into the curriculum, as though it was *built for them*

- “When students feel safe in a positive environment, learning will flourish.” [4] Acknowledging this, we wanted to support these kids in furthering their education by making an activity that is closely connected to the culture of our students.
- If your students also like fidget spinners, we think this would also be a great activity for them! Even if that’s not the case, we found in this activity that students were able to make their fidget spinners whatever they wanted them to be. Some of our students put their favorite musical artists on theirs. Others drew patterns and symbols that held deeper meaning to them. We suggest you encourage these students in finding their own culture within their work, even in seemingly unimportant situations!

## Please use these materials and tailor them to your students!

We encourage you to use these materials, editing and modifying them as appropriate for your students in your particular context! When you use, share, incorporate, or modify these materials, please keep the credit and license notice from the footer. We also humbly request that you email sarah.adams@olin.edu if you use these materials, as we are tracking their impact and how far they travel!

## References

References used in the motivation and design of our workshop and/or extensions.

[1] (2) Easy Fidget Spinner WITHOUT Bearings TEMPLATE - How to make a Tri Fidget Spinner DIY - YouTube

[2] Super Spinners! - Activity - TeachEngineering

[3] Easy forces science lesson plan with free spinning tops printable - NurtureStore
All three of the above sources were references we used when determining the feasibility of our lesson plan. We think that they give a good amount of context as to the quality + difficulty of fidget-spinner fabrication.

[4] https://todayslearner.cengage.com/the-benefits-of-culturally-responsive-teaching/
This is a resource we consulted early on in our curriculum development when trying to tie in effective teaching methods with our lesson plans.

**ADDITIONAL HANDOUTS**

Here are some of the worksheets that we used. Please feel free to print them out directly, or make your own!

There are day 1 and day 2