

2021

## Hands-on Developmental Playbook for STEM Clubs in Elementary Schools

James Lipuma

*New Jersey Institute of Technology*, lipuma@njit.edu

Bruce G. Bukiet

bruce.g.bukiet@njit.edu

Cristo Leon

*New Jersey Institute of Technology*, leonc@njit.edu

Follow this and additional works at: <https://digitalcommons.njit.edu/stemresources>



Part of the [Applied Mathematics Commons](#), [Arts and Humanities Commons](#), and the [Education Commons](#)

---

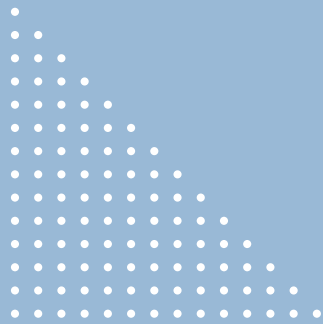
### Recommended Citation

Lipuma, James; Bukiet, Bruce G.; and Leon, Cristo, "Hands-on Developmental Playbook for STEM Clubs in Elementary Schools" (2021). *STEM for Success Resources*. 3.

<https://digitalcommons.njit.edu/stemresources/3>

This Guide is brought to you for free and open access by the STEM for Success at Digital Commons @ NJIT. It has been accepted for inclusion in STEM for Success Resources by an authorized administrator of Digital Commons @ NJIT. For more information, please contact [digitalcommons@njit.edu](mailto:digitalcommons@njit.edu).

# STEM for Success



→

HANDS-ON  
DEVELOPMENTAL  
PLAYBOOK  
FOR STEM  
CLUBS IN  
ELEMENTARY  
SCHOOLS

←



**04 INTRODUCTION**

**07 PURPOSE**

**10 STARTING A CLUB**

PRE-RECRUITMENT

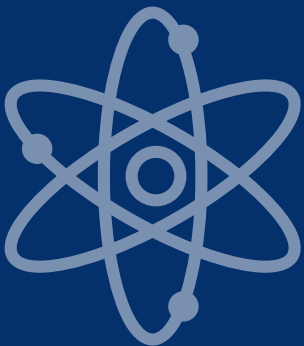
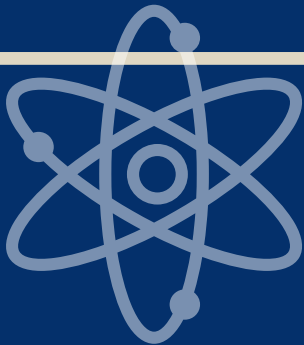
MEMBER RECRUITMENT

CLUB COORDINATION

# TABLE OF CONTENTS

**04 LESSON PLANS**

# INTRODUCTION



In today's innovative society, science, technology, engineering, and math (or STEM) is prevalent in almost every professional field in some capacity. We aim to expose elementary school students to interactive STEM activities through STEM-based clubs in their schools. By

being a part of such a club, children can discover and engage with a passion to advance the STEM field. There is an increased likelihood

that this young interest will blossom into a prominent passion in the future. Moreover, they are empowered to develop significant cognitive reasoning skills and engage with STEM topics and subjects in unique manners. Students will

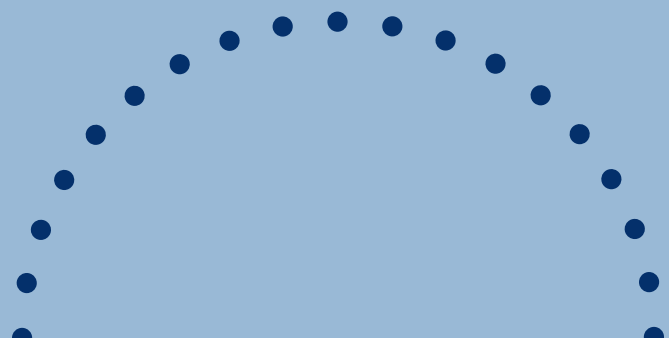
gain more confidence with expressing their thoughts and opinions, since they would be exposed to diverse topics. In whole, it is very critical that children gain exposure to STEM early on in their lives, specifically during their formative years. Especially for young women,

STEM clubs have the potential to combat gender representative gaps in STEM, as they help encourage critical cognitive reasoning and communication skills.

# PURPOSE

Especially at the elementary level, developing and running a STEM club within your own school can be challenging. That is why we have developed “insert title of playbook here”. Our playbook serves as a vital resource for teachers and parents alike who want to start a STEM club at their or their child’s school, respectively, or those who wish to make improvements or modifications to their already-established clubs or programs. Throughout these pages, you will find a multitude of information, first-hand recommendations, and sample activities and projects that will elevate your STEM program and its curriculum. We hope that this playbook serves as a system of support and inspiration for both you and your students, who are developing critical thinking skills through hands-on activities.

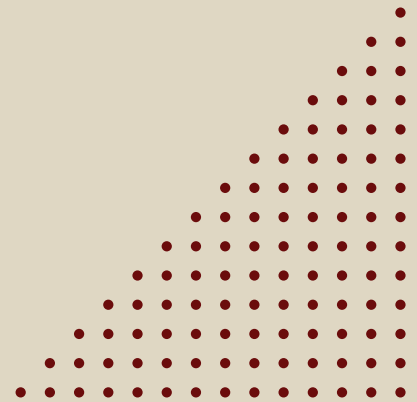
**There is no single formula to make a successful club.** Every school and its environment, students, and needs is unique and deserves personalized and malleable plans and activities. However, we hope that we can provide you with a basic framework that helps you achieve your club’s purpose, focus, and maximize the impact on your students.



# STARTING A CLUB



**PRE-RECRUITMENT  
MEMBER RECRUITMENT  
CLUB COORDINATION**

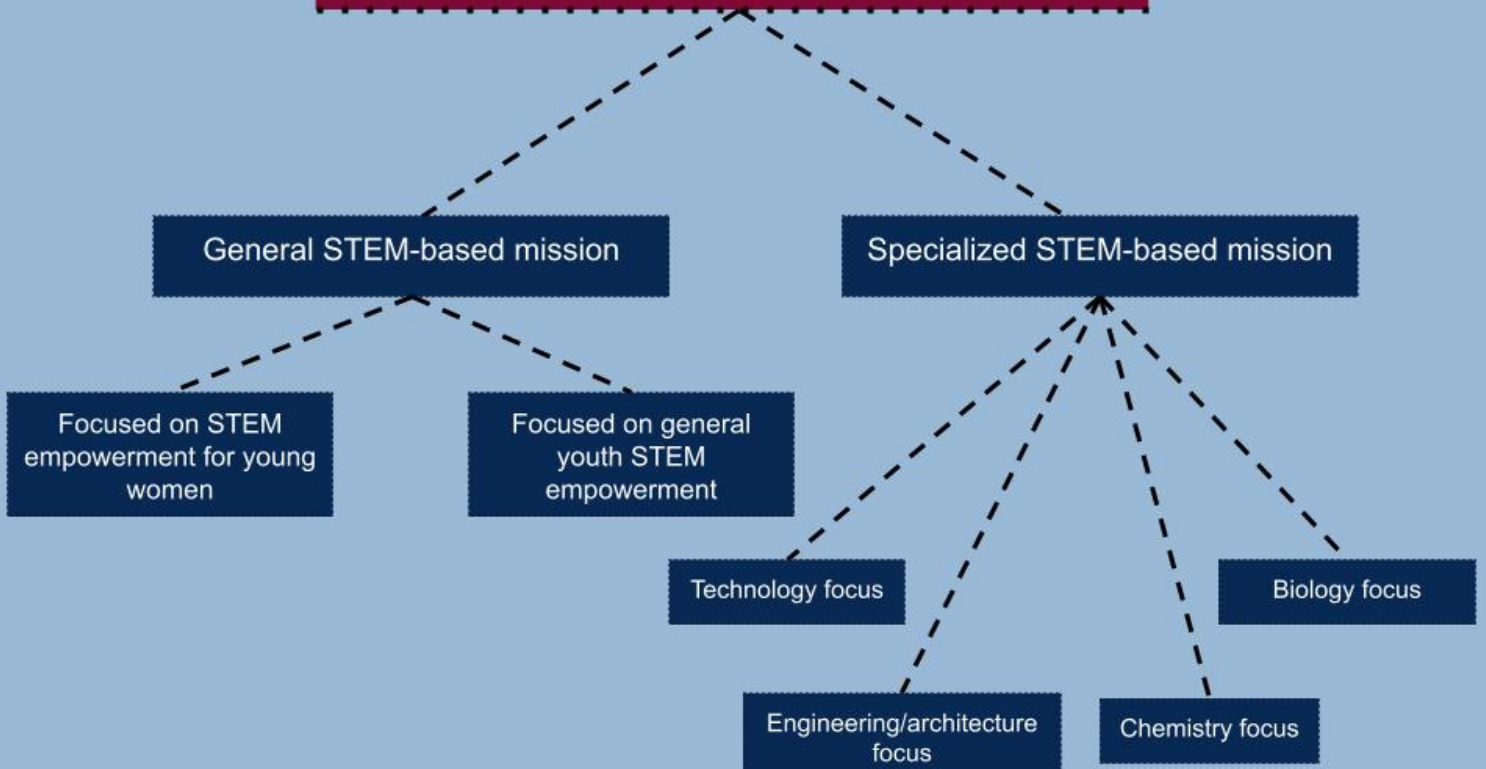


# PRE- RECRUITMENT

---

Before beginning recruitment of any kind, a plan must be created for your club. Every single meeting STEM-based activity does not need to be planned out at this point! It is completely okay to plan on a rolling basis, based on student need and/or interest. However, at this point, it is important to consider what direction you would like your club to head in. You have plenty of options at these preliminary stages of forming your club. Here, we have created a comprehensive web of potential directions you can push your club towards, based on the needs of your school's students. Consider offering the resources and curriculum of the club as an elective class within your school, if and when possible! This could open up the possibility of exposing your students to the world of STEM while they pursue appropriate academic credit.

# Pre-Recruitment Decision Map for STEM Clubs





# MEMBER RECRUITMENT

---

One of the best ways to boost recruitment is to send promotional flyers to classrooms within your school. This can be done physically or virtually. Examples include hanging flyers around your school, distributing them at staff meetings or within staff mailboxes to hand out to students, making morning announcements, sending out mass emails to students and/or teachers, posting on your school website, or posting on your school's respective online academic portals (Google Classroom, Canvas, Blackboard, etc.). See examples of these promotional flyers on the next couple pages. We encourage using these flyers as templates, with the details and/or format tailored to your school!

To both organize and maximize registration, a Google Form or online survey of any kind is recommended! Alternatives include directing students and/or parents to email a certain person or office or administering in-person interest forms and meetings, if the opportunity arises. If too many applications are received, the most ideal form of selecting students for your respective club is to conduct a randomized hat lottery to ensure fairness. If there is a lot of interest, your club may also choose to operate in two different "blocks", both lasting for approximately half of a school year but with identical curriculums.

**CURIE MIDDLE SCHOOL**

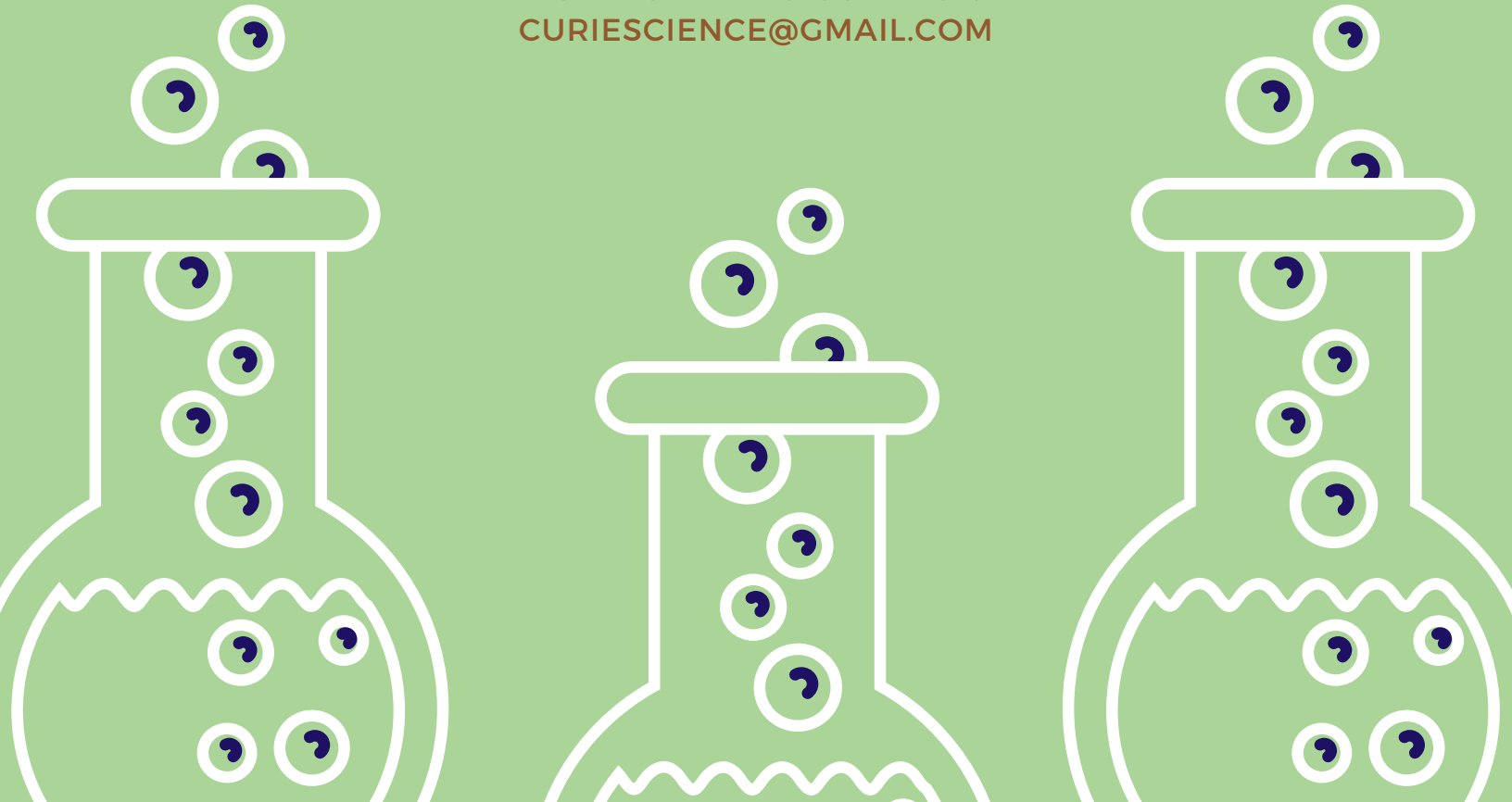
# **THE CHEMISTRY CREW**

**JOIN US FOR FUN WITH SLIME,  
EXPLOSIONS, ICE CREAM AND SO  
MUCH MORE!**

**EVERY MONDAY 4-5 PM  
CLASSROOM 100**

**HANDS ON ACTIVITIES IN STEM  
GRADES 4-6 WELCOME**

**FOR MORE INFO CONTACT:  
CURIESCIENCE@GMAIL.COM**



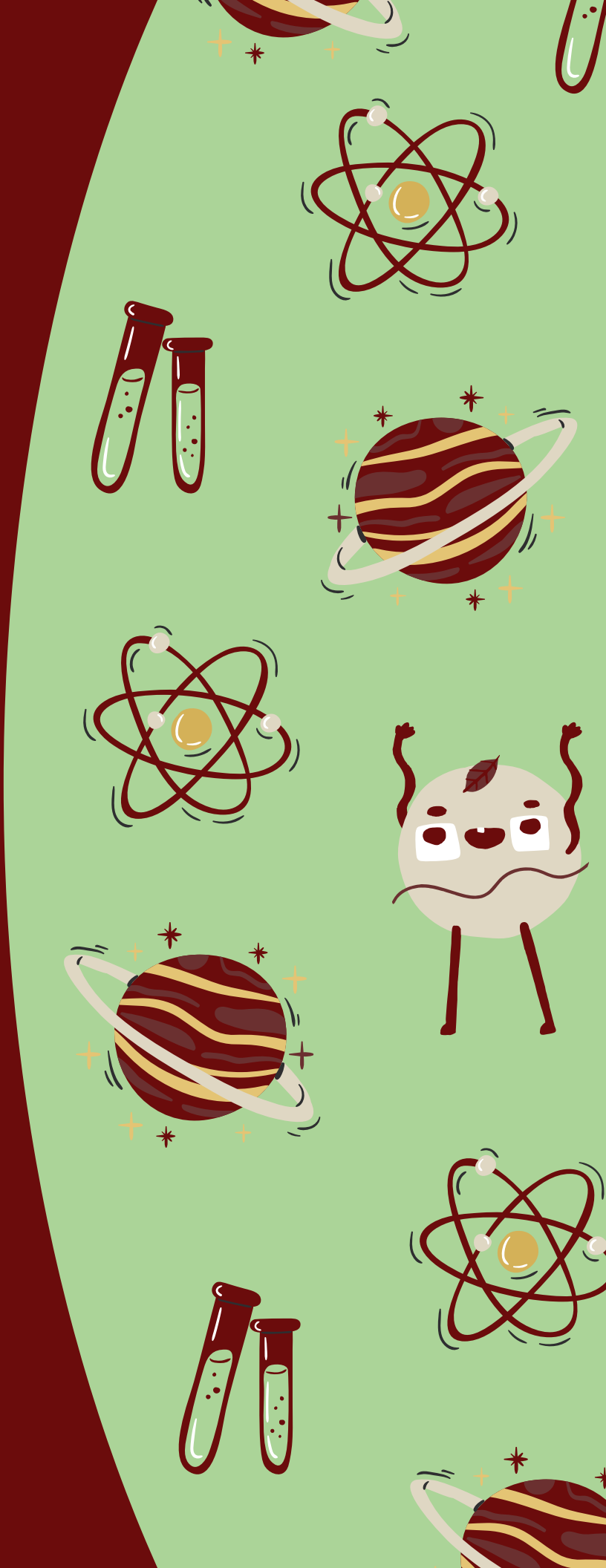
SHIRLEY GRADE SCHOOL

# MAD SCIENCE

GRADES 4-6 INVITED

JOIN FOR FUN HANDS  
ON EXPERIMENTS!

MAKING SLIME,  
COOKING WITH  
CHEMISTRY, CREATING  
ROLLER COASTERS AND  
SO MUCH MORE



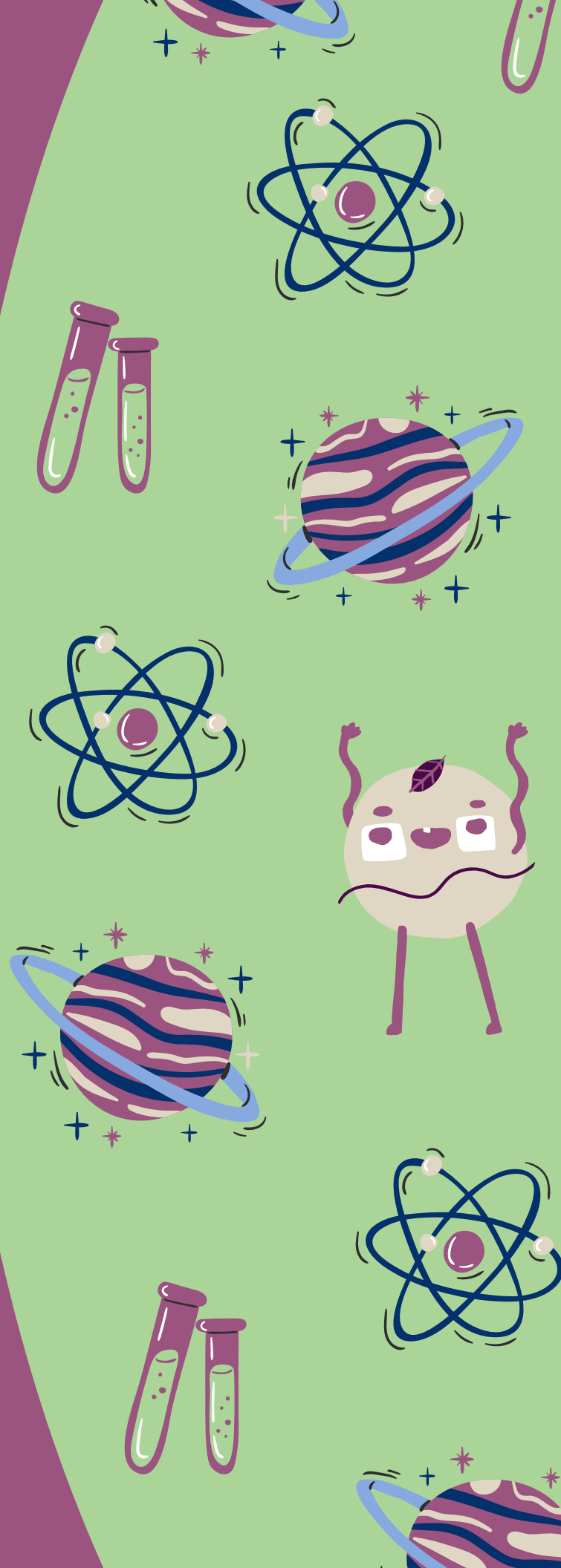
SHIRLEY GRADE SCHOOL

# GIRLS ROCK SCIENCE

ALL GIRLS  
GRADES 4-6  
INVITED

JOIN FOR FUN  
HANDS ON  
EXPERIMENTS!

MAKING SLIME,  
COOKING WITH  
CHEMISTRY,  
CREATING  
ROLLER  
COASTERS AND  
SO MUCH MORE



# CLUB COORDINATION

---

Either during or after narrowing the focus of your club, getting it approved, and recruitment, you must begin coordinating logistics. You must choose a running time, date, and location for your STEM club. The time and date can be narrowed down by either location availability or whatever time receives the most student/parent support. The location decision is one that must be tailored to your specific school, depending on the size of your club, size of the school, and administrative guidelines.

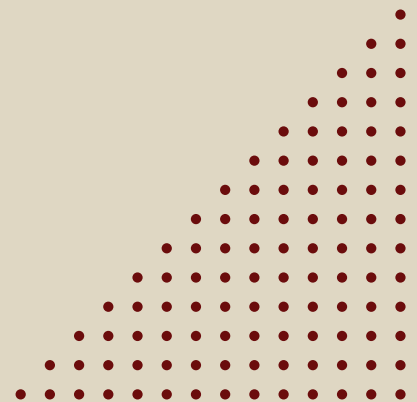
As with any other club, permission slips must be issued to the students for their respective parent or guardian to sign. This should be done in accordance with your school's guidelines.

A useful tool to utilize before beginning any club meetings or activities is a pre-survey (and a post-survey that follows the last meeting or activity), such as the one on the following page. This could indicate progression of both STEM appreciation and/or knowledge for each individual student.

# IMPLEMENTATION



**CLUB LOGISTICS  
CRITICAL THINKING  
EXPANDING THE CLUB**



# CLUB LOGISTICS

---

Running a STEM-based club at an elementary level does not come without its challenges. It takes time and commitment to maximize the impact that your STEM activities have on your students.

We already mentioned choosing a recurrent time, date, and location for club meetings. Another factor that could help your club run smoothly is to incorporate club meetings as part of either a regular school curriculum or offer it as an extracurricular activity, along with the others that your particular school might offer. Not only does this ensure that both the teachers' and students' schedules are not impacted by club activities, but it also minimizes any extra financial or opportunity cost that might come from scheduling your club as a brand-new commitment.

# CLUB LOGISTICS

---

An important logistical factor to consider as you lead your club is group size. Several of the lesson plans and experiments mentioned and not mentioned require or encourage student collaboration. In our experience, we have found smaller group sizes (2-3 students per group) to be the most effective. This size offers more pointed interaction between students, while still making it realistic for each student to voice his or her ideas and agree with others. On the other hand, this group size is also ideal for students to learn how to disagree while also remaining productive, which is a crucial skill in a collaborative setting.

A final tip is to hold debrief sessions in any capacity after each club session.

These sessions can either be internal sessions with teachers, coordinators, etc. or with the students, to receive both positive and negative feedback. This is the best way to ensure that your club flourishes!



# FOSTERING CRITICAL THINKING

---

STEM clubs do not solely serve the purpose of expanding students' technical knowledge! Make sure to nurture a comforting and safe environment. Sometimes, when clubs get started, students who do not know each other find it difficult to interact with others. Students need to feel secure enough to speak their minds and share their ideas, especially in a collaborative environment. This can build both confidence and respect at an early age. Communication is key! Make sure you have an open dialogue with your students, so that they know that they are able to talk to you safely within the classroom. Make sure to incorporate time dedicated to critical thinking for each club activity. Students should be able to work together on, think through, and plan out their projects before actually beginning the project.

# FOSTERING CRITICAL THINKING

---

Make connections between the activities from the club to the world outside the classroom! This allows them to not only apply technical skills in real life, but also potentially pursue inquiry-based learning projects, which are viable options towards the ends of each course for the club. Further, making connections between the students' direct community and the classroom creates valuable partnerships that maximize learning for children, and the transcension of boundaries creates new STEM-based perspectives for them. Along with fostering STEM through grade-appropriate activities, educate your students about careers in and related to STEM! This shows them the range of tangible opportunities awaiting them as they progress through their educational careers. This can be done by inviting various speakers, guests, or even club alumni to promote social and emotional learning.

# EXPANDING THE CLUB

---

As your club progresses, keep interest in your club flowing! Highlight student testimonials on your school website, newspapers, etc. This shows the real-life impact that the STEM club had on the students, and it encourages both students and parents to get involved and gain valuable experiences.

Use social media to spread the word! We know what it is like to live in a world that operates virtually. Capitalize on all social media platforms to spread your club's mission and registration process!

Despite the virtual progression of the classroom, word of mouth is still key to maximize the impact of your club. Encourage students and parents to share their experiences with those in the community. Hold science fairs, symposiums, etc. to display student work and projects! This is one of the best forms of reward for the hard work your students put into the club, and it displays the effectiveness of your club activities and mission to the rest of the school and community.

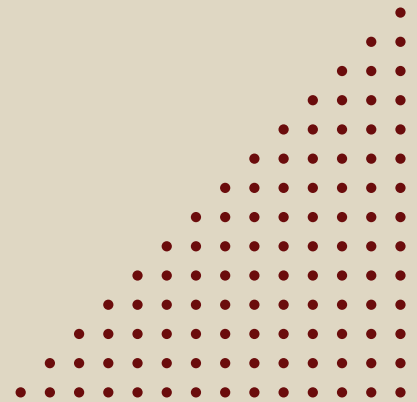
# LESSON PLANS

---



---

**ACTIVITY TEMPLATE  
SAMPLE LESSON PLANS  
IDEAS**



# HOW TO USE

In this section, we detail how lesson plans should be made, with a template which is linked as pdf. We've included examples across various disciplines. These may be used for general STEM clubs or specific ones (astronomy club, chemistry club, etc.) Some lesson plans have been done previously, with teacher and STEM for Success Mentors' feedback and the template filled out. These lesson plans are meant to serve as a starting point or reference point: feel free to personalize to your students

## SECTIONS:

Template

Template examples

Biology ideas

Chemistry ideas

Physics/Engineering ideas

Astronomy ideas

# TITLE

## *PRE-ACTIVITY*

Name of activity:

Age/Grade range:

STEM discipline(s):

What topic does this activity relate to?

**Pre-work** (what students should know or prepare before doing engaging in this activity; what teachers need to prepare before leading the activity):

What should the students learn by the end of this activity?

Tools/supplies needed (indicate quantity and if it needs to be bought + price range):

Total price (indicate per class or per student):

Step-by-step instructions on how to conduct the activity (attach link if found online and make note of modifications for your class here): (Include e.g., size of groups, images of materials or people doing the activity that might help the reader lead the activity, helpful supporting materials)

### ***DURING ACTIVITY:***

Number of students present:

What modifications had to be made to the lesson plans and why (if any)?

Provide feedback: teacher observations, specific student feedback, work products:

### ***POST-ACTIVITY (REFLECTION):***

What aspects of the activity worked well?

What can be improved on?

What suggestions do you have to adjust the lesson for different purposes or populations?

If money was spent on tools/supplies, in your opinion, was the investment worth it?

Provide thoughts on alternative materials, steps or other modifications that might be worthwhile for others to consider.

Additional notes:

\*pdf version linked

# TITLE

## *PRE-ACTIVITY*

Name of activity:

Age/Grade range:

STEM discipline(s):

What topic does this activity relate to?

**Pre-work** (what students should know or prepare before doing engaging in this activity; what teachers need to prepare before leading the activity):

What should the students learn by the end of this activity?

Tools/supplies needed (indicate quantity and if it needs to be bought + price range):

Total price (indicate per class or per student):

Step-by-step instructions on how to conduct the activity (attach link if found online and make note of modifications for your class here): (Include e.g., size of groups, images of materials or people doing the activity that might help the reader lead the activity, helpful supporting materials)



# RACECARS AND RAMPS

## **PRE-ACTIVITY:**

**Name of activity:** Using Ramps and Toy Cars to demonstrate energy transfer

**Age/Grade range:** Any

**STEM discipline(s):** Physics

### **What topic does this activity relate to?**

(Potential energy, Kinetic energy, Transfer of energy to motion)

**Pre-work** (what students should know or prepare before doing engaging in this activity; what teachers need to prepare before leading the activity):

### **What should the students learn by the end of this activity?**

The goal of this lesson is to demonstrate to students how different types of energy relate to each other, and how potential energy can be transferred to kinetic energy. The students should end with an understanding of how a higher height (potential energy) will lead to a greater speed (kinetic energy) → the height and speed are directly proportional.

### **Tools/supplies needed (indicate quantity and if it needs to be bought + price range):**

Simple cardboard ramps were used at the time of the experiment, more sophisticated cramps could be used if desired. The simple cardboard ramps were constructed using recycled cardboard by cutting and taping the cardboard to create the desired ramp heights and lengths. One ramp was made to be significantly taller in height than the other.

### **Total price (indicate per class or per student):**

Hot wheels car (2) - \$0.99 each

Cardboard - recycled free

### **Step-by-step instructions on how to conduct the activity (attach link if found online and make note of modifications for your class here): (Include e.g., size of groups, images of materials or people doing the activity that might help the reader lead the activity, helpful supporting materials)**

-Note: Students had seen a previous demonstration on how height is related to potential energy. Students were shown ramps, and asked to list the differences between the ramps (height of ramp, length of ramp). Based on those observations, they were then asked to predict which ramp would the toy car go down faster, and why. The cars were then let down the ramps (participation from the students) at the same time and the students observed. They then analyze what they saw, and choose which car went down the ramp faster (taller one). The students were asked if this match or disagreed with their previous predictions. Students were then asked to create an explanation for why one car travels down the ramp faster (height of ramp). The concepts of energy, potential and kinetic, were then reintroduced and the connection on height and potential energy was reinstated. The connection of energy transfer, relating height to speed, was then introduced and explained to the students. BONUS → ask students if the length of the ramp matters (it does not)

***DURING ACTIVITY:***

**Number of students present:**

**What modifications had to be made to the lesson plans and why (if any)?**

Ramps were too similar in height. Students that we originally did the experiment with had done a very similar experiment with their teachers prior to our engagement

**Provide feedback: teacher observations, specific student feedback, work products:**

***POST-ACTIVITY (REFLECTION):***

**What aspects of the activity worked well?**

**What can be improved on?**

Ramps could have had more difference in height, caused confusion when speed of cars was not that different and hard for students to notice

**What suggestions do you have to adjust the lesson for different purposes or populations?**

Cars of different masses can be used to show that mass does not affect the speed

Can introduce rotational energy of the wheels

Can be used to demonstrate {simpler activities}

**If money was spent on tools/supplies, in your opinion, was the investment worth it?**

**Provide thoughts on alternative materials, steps or other modifications that might be worthwhile for others to consider.**

**Additional notes:**

# SUGAR WATER

## **PRE-ACTIVITY:**

**Name of activity:** Sugar Water Density Rainbow

**Age/Grade range:** Any

**STEM discipline(s):** Chemistry

**What topic does this activity relate to?**

Density of various solutions

**Pre-work** (what students should know or prepare before doing engaging in this activity; what teachers need to prepare before leading the activity):

**What should the students learn by the end of this activity?**

Student should understand how the density of a solution affect how the solutions layer onto each other

**Tools/supplies needed (indicate quantity and if it needs to be bought + price range):**

Sugar cubes

Clear plastic cups

Sharpie markers

Food coloring

10 ml syringes

water

**Total price (indicate per class or per student):**

Sugar cubes (1lb) : \$12

Clear plastic cups (100 pack) : \$12

Sharpie markers (12 ct) : \$18

Food coloring (basic 4 colors) - \$3.50

10 ml syringes (100 ct) : \$13

**Step-by-step instructions on how to conduct the activity (attach link if found online and make note of modifications for your class here): (Include e.g., size of groups, images of materials or people doing the activity that might help the reader lead the activity, helpful supporting materials)**

-First the cups were labeled 1-6, and 3oz ( $\frac{1}{3}$  cup) of hot water was added to each cup. Food coloring was added to each cup (listed below). Then sugar cubes were added to each cup (listed below) and dissolved in the water. Students then took a 10 mL syringe and filled about 2mL of the red solution from cup 1. This repeated with all the other colors to create a rainbow in the syringe. After making and observing the initial rainbow, students are asked to carefully flip the syringe upside down and observe what happened to the rainbow.

Cup	color	Number of sugar cubes
1	Red	0
2	Orange	3
3	Yellow	5
4	Green	7
5	Blue	9
6	Purple	11

***DURING ACTIVITY:***

Number of students present:

**What modifications had to be made to the lesson plans and why (if any)?**

Ramps were too similar in height. Students that we originally did the experiment with had done a very similar experiment with their teachers prior to our engagement

**Provide feedback: teacher observations, specific student feedback, work products:**

***POST-ACTIVITY (REFLECTION):***

**What aspects of the activity worked well?**

**What can be improved on?**

instead of syringes the colors can be layered in another clear vessel

**What suggestions do you have to adjust the lesson for different purposes or populations?**

Experiment might be able to be done with salt instead of sugar

**If money was spent on tools/supplies, in your opinion, was the investment worth it?**

**Provide thoughts on alternative materials, steps or other modifications that might be worthwhile for others to consider.**

**Additional notes:**

# IDEAS - BIOLOGY



## Planting flower / vegetable plants (long-term experiment)

Give each student a paper cup filled with dirt and seeds that they assembled in class w/ a handout indicating how to take care of the plant at home and ask for pictures periodically

Grow them in class and have students observe plant's life cycle over the course of the school year

Compare/contrast what helps plants grow and what doesn't (sunlight vs. no sunlight, water vs. Gatorade, regular water vs. sugar water, etc.)

## Terrarium

If funds/access to environment permit, terrarium (requires airtight glass jars (i.e. mason jars), clean sand/gravel, plants, rocks, soil, water, and activated charcoal)

## Food web diagrams

Can be led by the students as opposed the teachers - let them figure out web, and then correct them / ask questions, as needed)

## Create a compost at your school!

(long-term experiment - have students collect applicable waste once a week/month at lunchtime, and add to a usable compost pile in school yard)

## Life cycle of an animal

Metamorphosis of a butterfly (get a caterpillar as a "class pet" and observe over the course of the school year, make diagrams on paper plate/piece of paper divided into four sections, etc.)

## Evolution

Show predator/prey relationships (i.e. scatter rocks/jellybeans/green pieces of paper on classroom and see how many each student finds, then scatter outside in grass and see how many are found [should be less found in grass], and demonstrate how some prey in the wild hide from their predators)



# IDEAS - CHEMISTRY

## Growing sugar crystals

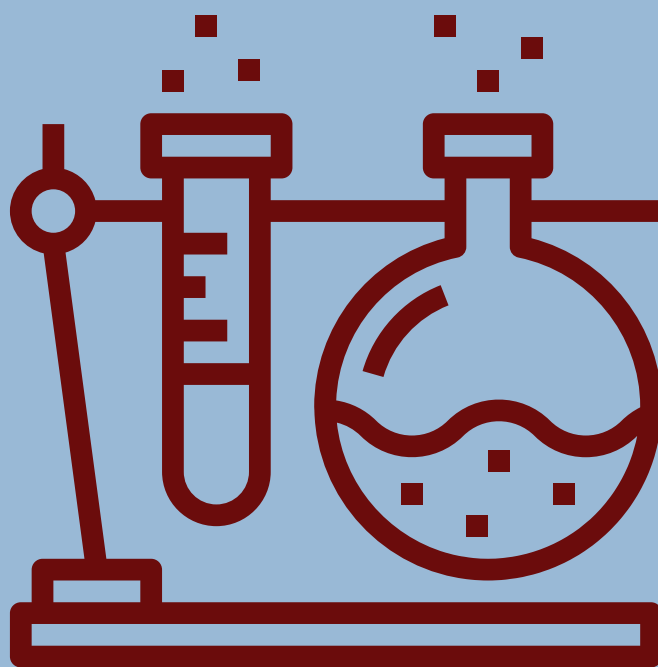
With teacher supervision, boil water while slowly adding sugar, and add solution to a jar. Dip strings attached to pencils in and close jar. Watch crystals grow! Students will learn about supersaturation and crystallization.

## Dissolving M&Ms

In solutions of water, oil, and isopropyl alcohol, watch M&Ms dissolve. Students will be able to learn about charges of substances.

## Boats

Students will cut out two "boats" from styrofoam, one coated with detergent, and let it dry. Fill up a flat tray with water, and race both boats. Observe what happens. Students will learn about cohesion and other water properties.



# IDEAS - PHYSICS / ENGINEERING

## Money and Energy

Distribute money to students, give each student varying amounts (1-5). Ask them who can buy more with their money, and why students with less money cannot buy as much as students with more money. Explain that the money in their hand is like potential energy, it can be used to do work (buy things) more energy (money) means more work can be done (can purchase more).

## .Cardboard buildings

Allow students to be creative and create their own structures and understand the basic process of designing buildings. Students had to work with whatever materials were available to them, limiting what they would discard from the cardboard pieces

## Building bridges

Students will learn and understand different types of bridges, as well as the best situations for each. They will understand the design process when it comes to building and problem solve.

## Basketballs

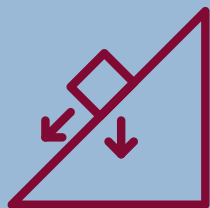
2 Basketballs are to be held at different heights, and students will be asked to predict which one had more potential energy and why, predict which basketball would be faster, and which would hit the ground first and why. After observing the experiment in action, the students will compare with their original predictions and if they were correct or not.

## Marble Run

Students will be given the materials to create the marble run along with a sheet of paper for planning. They will then be asked to work with their group to brainstorm and design the pathways for their marble runs, and sketch out their designs on paper before they started assembling. Once students construct their final designs they will test them to make sure they worked, modifying them if needed. They should then be asked to brainstorm with their group ways to improve their setup and record five trials.

## Circuits

Students will be given circuit kits to play around with and recreate projects from the booklets.



# IDEAS - ASTRONOMY

## Solar system model

Give each student one long skinny wood craft stick and 10 short strings (including the Sun), tape each piece of string to the craft stick, add Sun + planets\*

Give each student one black poplaster paper and add Sun + planets directly on poster\*

Give each 10 student styrofoam balls (paint/decorate as desired) and nine long skinny wood craft sticks, with one ball representing the sun (in the middle) and the other nine balls representing planets, connected to Sun with craft sticks

\* for Sun + planets, use styrofoam balls), circular pieces of paper, or anything else convenient and available; be sure to label; can paint/decorate as desired; can correspond each planet with a relative planet size

## Life cycle of a star

Use flowchart to represent possible stages of star life

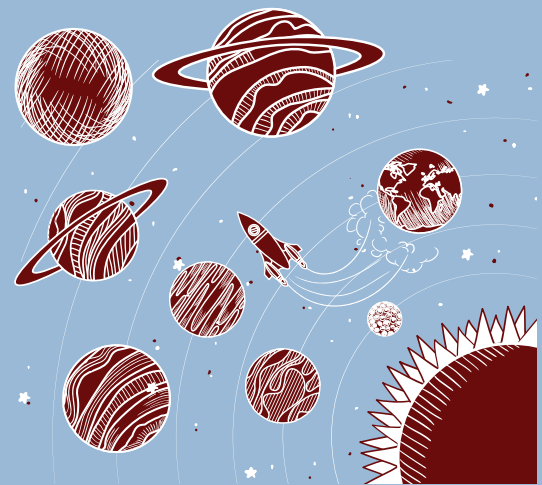
## Moon phases model / journal (can show that the Earth rotates on its axis, causing moon phases)

Can be short-term project → reference solar system model for moon phase model

Can be a long-term project → have students keep a “journal” or give handout, with them recording moon phase every day for one month

## Constellation identification

Make constellation cups! Give each student/group a few paper cups and printouts of constellations, have them poke holes in bottom of cup matching constellation pictures and label cups, turn off lights, and shine flashlight through each cup towards a blank wall to see “at-home constellations”





# CONCLUSION

It is never too early or never too late to begin exposing your students to the world of STEM. STEM is a diverse ecosystem that encompasses multiple disciplines, with each discipline having its own skillset. Through the formation of your own STEM clubs targeting elementary schoolers, you have the opportunity to not just help your students grow academically, but to learn critical collaborative and interpersonal skills that are crucial for their upcoming years in school.