STEM 4 Kids: Improving Gender Diversity in STEM through a Collegiate Student-led Organization

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Abstract

Gender diversity has always been a low statistic in science, technology, engineering, and mathematics (STEM) fields. To see change, improvements must be made at every age point - from the selection of children's play toys, to the recruitment of students from historically marginalized groups to pursue STEM degrees, to the pay disparity in career fields today. STEM 4 Kids, a student-led organization at Colorado State University (CSU), focuses on improving the diversity gap at one of those points in the development of future engineers: at the middle school level. STEM 4 Kids is open to all middle school students, but focused specifically on marginalized and underrepresented groups such as young women and non-binary identifying students. Middle school students are invited to participate in free hands-on activities to encourage creativity and foster confidence. In an effort to introduce students to a variety of activities and topics, STEM 4 Kids partners with other student-led organizations on the same campus. These other organizations can volunteer to host an event, which entails teaching the students about their specific STEM field and leading the activities. By the end of the 2023 fall semester, STEM 4 Kids had hosted 28 events with over 120 total registrants. This paper will discuss the process of establishing such an organization at the collegiate level and partnering with other student organizations.

Introduction

During the fall of 2021, a small group of students who were part of the Colorado State University (CSU) chapter of the American Society of Mechanical Engineers (ASME) started a local STEM outreach initiative. The program was founded to provide middle school students with free access to events with hands-on STEM activities. The primary goal of these events was to provide a safe space to foster the growth of confidence and interest in STEM in young girls and non-binary students. Students of all genders and backgrounds were encouraged to attend events to provide opportunities to work with others of diverse backgrounds and experiences. Since a strong factor that kindles students' initial interest in STEM is extracurricular activities, STEM 4 Kids sought to provide an opportunity for the local community [1]. The events were held on CSU's campus where parents drop-off and pick-up their students.

The program separated from ASME, and in spring of 2022, it became its own registered student organization. This stemmed from the realization that running an outreach program required more support from faculty and student volunteers than could be given as a small section of a larger organization. STEM 4 Kids remains active and continues to provide middle school students with

free access to events with hands-on STEM activities. This paper will detail the process of developing a new collegiate student-led outreach organization. This will include the formation of STEM 4 Kids, the leadership roles within STEM 4 Kids, how activities are developed, a description of the events, working with other organizations, and community outreach and advertisement.

Formation of the Organization

STEM 4 Kids was founded within CSU's ASME chapter as an outreach initiative. At the time, the collegiate-student authors of the paper were members of that chapter and formed the STEM outreach subcommittee. As subcommittee members, the primary tasks were to think of STEM activities that would be appropriate at the middle school level. This paper will cover more of activity development in a later section.

ASME met weekly and a group of four to five members would spend twenty minutes during the meeting to discuss activities and how to best engage middle school girls and non-binary students in those activities. Some weeks, there would be no time remaining for outreach planning after ASME business was discussed. It became clear to the outreach team that there was a need for more dedicated preparation time to have a successful program. After meeting with CSU's student leadership office, three of the ASME Outreach members began the process of creating a new registered student organization (RSO). The minimum requirements for a new RSO were to write a Constitution for the organization, have a Faculty Advisor, and have the roles of President, Vice President, and Financial Officer be filled by current CSU students. The three members that initiated the RSO process wrote a Constitution, reached out to a professor that was interested in becoming the Faculty Advisor, and filled in the three required roles.

The new Constitution was created, which included information on how and when elections were to take place, the requirements for being on the leadership team, and what the leadership roles and responsibilities were to be. The members decided that in addition to the three required roles, STEM 4 Kids would have the roles of Secretary, Volunteer Coordinator, Design Chair, Communications Coordinator, Registered Student Organization Officer/Engineering College Council Representative, and Webmaster. The responsibility of each position is described in the next section.

Leadership Roles within the Organization

The President is responsible for the management and successful operation of STEM 4 Kids at CSU. This includes oversight of delegation of duties among officers and committees,

organization and coordination of various outreach events, ensuring club goals are set and met, running club meetings and elections, maintaining and facilitating communication with departments, and representing STEM 4 Kids in department, donor, and other official meetings. The Vice President aids the President in all of their duties and acts as president in the event of the President's absence. They also ensure the events are properly staffed with volunteers and event leaders and correspond regularly with the Volunteer Coordinator to ensure all participants have completed the background check process.

The Financial Officer will maintain all accounts related to STEM 4 Kids' activity and ensure all money is accounted for in and out of accounts. They are responsible for keeping and maintaining an excel spreadsheet of all event expenses, discovering new ways to access money or seek sponsorship, creating budgets for potential projects and ensuring all money needed for said event is available, and filing away all receipts and invoices for expenditures in a centralized location. The Secretary is responsible for organizing and retaining club information and for facilitating club-to-student body communication. They also maintain an organized log of all club discussions held during general meetings, keep a master calendar of upcoming events, and create a master list of tasks that need to be accomplished as stated by president and vice president during meetings. The Volunteer Coordinator is responsible for ensuring the successful integration of new volunteers into the STEM 4 Kids' volunteer committee. They are also responsible for coordinating the volunteers that will be assisting at events. Additionally, they create an itinerary for each event that assigns tasks to officers and volunteers. This primarily consists of set up and tear down tasks so that everyone has an opportunity to participate and to make sure everything gets done in a timely manner. Since STEM 4 Kids works with minors, the Volunteer Coordinator also ensures all volunteers have received a CSU background check before volunteering at an event.

The Design Chair is responsible for any and all design related aspects including signs, banners, flyers, and t-shirts, as well as ensuring all designs are CSU approved. The Communications Coordinator is responsible for all off campus communication for execution of organization events. This primarily consists of maintaining a running list of all contacts and following an email schedule to ensure parents and/or students receive registration confirmation and event information emails. The Registered Student Organization Officer/Engineering College Council Representative is responsible for attending weekly Engineering College Council meetings and reporting updates to STEM 4 Kids' leadership about upcoming opportunities in the college. The representative is also responsible for communication between STEM 4 Kids and other registered student organizations. More details about this collaboration will be presented in a future section. The Webmaster is responsible for upkeep and updating STEM 4 Kids' webpage, as well as managing and executing any online platform for outreach, marketing, and data collection. Some of these roles were filled by ASME outreach subcommittee members, while rest were offered to student volunteers at the first few events held and were quickly filled.

Developing and Implementing Activities

When developing activities for the events, there are many criteria to consider. The activities need to be engaging, educational, and incorporate STEM. The development process typically includes first deciding if there will be a specific "theme" for the event. For example, previous themes included upcoming holidays or focused on specific types of STEM -- such as robotics and coding or structures with catapults and bridges. From there, the team researches activities that fall within the theme or draw from the officers' own experiences. After deciding what the activity will be, they are modified to fit the needs of the event, and a bill of materials is created for supplies to be ordered. The ordering process is done through a CSU staff member with money allocated to STEM 4 Kids from CSU's Mechanical Engineering Department. Two days before an event, all officers and volunteers get together to go over the activity in detail and allow everyone to be on the same page and understand the concepts they are teaching. Additionally, everyone goes through the activity to ensure they understand how to do it and to weed out any potential issues with the initial plan. This lets the activity leaders focus on the students during the event instead of needing to fix procedural problems.

STEM programs can vary widely in focus, length, and execution [2]. STEM 4 Kids aims to have hands-on activities that teach basic engineering concepts and give the students the opportunity to design and critically think about what they are creating. This allows them to stay active and engaged throughout the whole event. Since this is an after-school program, the activities should also be fun for the students. Therefore, an important aspect of the events is that they do not feel like sitting in class and listening to a lecture, especially since the students just spent the day in school. Having the students learn through activities rather than lectures is called active learning, and it has been proven to be better than traditional lecturing regarding students' learning outcomes [3].

The STEM 4 Kids events begin with a short presentation to introduce the activity and use one or two slides to teach the concepts at an age-appropriate level. The volunteers then present the students with questions to think about as they envision their designs before beginning the activity. These questions allow the students to consider different aspects of their design and give them an opportunity to test their hypothesis. Some examples include:

- "At what angle do you think your catapult will launch the farthest or highest?"
- "How do you think changing the shape of your nose cone or your fins will affect the distance and height of your stomp rocket?"
- "Do you think the LED will become brighter or dimmer when you add a resistor to the circuit?"

After the lesson, the students will dive into the activity, and volunteers are available to offer advice when the students are struggling or if they have questions. The majority of the activities chosen are project-based learning activities where the students are presented with a task that is open-ended, and they are encouraged to analyze the problem and design their own version of the solution [4]. After the students are done with the design activity, the volunteers move onto a "testing" or competition phase. As examples, this has consisted of the students using their catapults and seeing whose would go the farthest, launching their rockets to see whose would go the highest, or testing bridges to see whose would hold the most weight. The competition aspect keeps the students engaged and interested in seeing what others came up with for their designs. The winners get to pick from a prize box with various items such as candy, building blocks, string lights, stickers, fun pens and pencils, etc. After this, there is another short lesson where the proposed questions are answered and the science behind it is explained. The students are then encouraged to reflect and self-evaluate their own experience of the activity so they can determine why their solution to the problem did or did not work [5].

An alphabetical, non-comprehensive list of activities put on by STEM 4 Kids is in the table below. Activities are hyperlinked to web pages with instructions or to sources for purchasing materials, with the exception of the 3D Printing, which links to CSU's Idea 2 Product Lab (I2P).

Table 1: List of STEM 4 Kids Activities

3D Printing	Apple-Powered Clocks	Balloon Lungs
Balloon-Powered Cars	Cabbage pH Indicators	Cartesian Divers
Cereal Mining	Circuits	DIY Bouncy Balls
DNA Jewelry	Egg Drop	Lego Launchers
mBots & Coding	Paper Circuits	Paper Roller Coasters
Popsicle Stick Bridges	Popsicle Stick Catapults	Prosthetic Hands
Sand Dams	Sand Mining	Slime/Oobleck
Spaghetti Bridges	Stomp Bottle Rockets	Strawberry DNA Extraction
Toothpick Towers	Turning Milk Into Plastic	Wobble Bots

Description of Events

The events are scheduled for two and half hours. This ensures that the students have plenty of time to work on activities and not feel rushed. Many of the events have two activities with a snack break in between, but some events have variations based on the activities planned, such as three shorter activities or occasionally one long activity with two parts. These variations come from both planning and from being flexible at events, recognizing when students need more time. The standard timeline for an event is as follows: setup, student check in, ice breakers, introductions, the first activity, a snack break, the second activity, clean up, parent/guardian pick up, tear down, and leadership/volunteer wrap up discussion.

The officers arrive first with all materials, snacks, and supplies for the event, and volunteers arrive soon after. A group of volunteers are stationed at a drop-off zone, where parents check in their students. During this time, another group of volunteers sets up the room for the activities, which typically includes setting up a powerpoint presentation, rearranging tables as needed, setting out supplies at each table for each student, and preparing any ice breakers for the day. Since the arrival of students varies from as early as 30 minutes before the event to as late as 15 minutes after the start time, the beginning of the events start with an icebreaker (or two). This also allows students to get some energy out before settling down to do an activity. Icebreakers are also good for student engagement and gives them a sense of community [6]. The icebreakers are chosen based on where the students are in the semester as well as weather conditions. If it is early in the semester, “getting to know you” icebreakers are typically chosen, where the students are required to talk to each other and learn names. If the students are already familiar with each other, team building activities are often chosen that require the students to communicate with each other in order to achieve a common goal. These icebreakers are also chosen in collaboration with activities that require group work.

Icebreaker activities have included:

- Captain’s Orders - This involves one student being “Captain” and calling out orders that must be followed by the rest of the students (“The Crew”). Orders are ship-themed like “Climb the Rigging” (students pretend to climb), “Man Overboard” (students drop the floor and pretend to swim), and “Shark Attack” (students make a shark fin with their hands).
- Team Pen - Four strings are tied around a pen or marker. Each student holds an end of the string and they must work together to write a word or create a drawing. The words or drawing prompts are given by the instructor.
- Group Cup Stacking - Four strings are tied around a rubber band. Each student holds the end of a string, and they must work together to use the rubberband to pick up cups and stack them in a variety of ways.

- The Line Up - The collegiate leader comes up with various ways the students have to line up, such as age, height, birthday month, number of siblings, or alphabetically by first or last name. The challenge is that the students must do it without talking.
- Paper Chain Race - The students race to build the longest paper chain in a set amount of time. The collegiate leaders may also limit the amount of paper each team receives.
- Get-To-Know-You Bingo - Bingo cards are created with prompts in each space, such as “plays a sport”, “has visited another state”, “has broken a bone”, and “can say ‘hello’ in another language”. The students must talk to other students and get them to sign their name on a space that is applicable to them. They cannot sign the same card more than once.
- Beach Ball Toss - Questions are written on the spaces of a beach ball. The students form a circle and toss the beach ball. The collegiate leader picks a hand and finger (Example: right hand, pointer finger). When the student catches the ball, they must answer the question that the hand and finger are on.
- “Who or What Am I?” - Students get a card taped on their back with a person or thing on it. They must speak with other students and ask only “Yes” or “No” questions to determine who or what they are.

After fifteen to twenty minutes of icebreaker activities, volunteer introductions begin. Every session starts with a description of the program and types of activities planned for the students. All the volunteers introduce themselves, their pronouns, their year in college, and their major. All volunteers and students wear name tags throughout the event. In an effort to provide a safe space for the students, they are encouraged to write whatever name they choose to go by and their pronouns on their name tags. For this same reason, they are not asked to self-identify on any forms or surveys they fill out.

The first activity is introduced and the officers describe the science and engineering behind it. After the short lecture, the officers walk through the steps of the activity, and the students get to begin working on their own or with partners, depending on the activity that day. Volunteers assist students with following instructions and answering questions, but the main goal is to allow the students to come to conclusions and get the opportunity to think through their problems independently at first.

After the first activity, there is a fifteen minute snack break. Snacks typically have consisted of fruit snacks, bars, applesauce, and a water bottle, with this inclusion of gluten free and vegan options. Having the snack break between the two activities has been a good way to keep students engaged for the whole two and a half hour event. It gives both students and volunteers the opportunity to take a break and interact more, allowing students to ask questions relating to STEM and college studies.

The second activity follows the same format as the first. Ten to fifteen minutes prior to pickup, the students are asked to clean up their stations and throw away any trash in their areas. Some ways to make this more exciting have been to make it a competition, such as who can clean up the fastest or who can throw away the most pieces of trash for a prize. The students then pack up, and a group of volunteers take them to the pickup zone to wait with them until a verified parent or guardian picks them up. During this time, another group of volunteers remains inside to finish cleaning up, rearranging the room to how it was before the event, and putting supplies away. After all students have been picked up by their parent or guardian, all volunteers have a discussion and reflection about the event to go over what went well, what could be improved, and what did not go well. This gives the volunteers the opportunity to evaluate themselves and the event as well as brainstorm improvements for future events.

These events were held every two weeks during a semester, resulting in six total events per semester with the exception of the first semester during which STEM 4 Kids was being formed and only four events were held. These events were held on CSU campus with students being dropped off and picked up by a parent or guardian and checked in and out by STEM 4 Kids volunteers to ensure the safety of the students. CSU and STEM 4 Kids require both safety and photo waivers to be signed by the students' parent or guardian before a student can attend an event, which are kept documented by STEM 4 Kids.

Volunteers and Working with Other Organizations

During the first semester of STEM 4 Kids (as ASME outreach), it was recognized that the activities that were planned were primarily mechanical engineering based. In order to represent STEM to the students, STEM 4 Kids would need to reach outside of ASME for assistance. While forming STEM 4 Kids as an RSO, it was decided to have an RSO Chair that is responsible for reaching out to and communicating with other RSOs in an effort to collaborate on events. An "RSO Package" was created in powerpoint to describe how a participating RSO should plan for an event, what to expect, and the content level they should provide to ensure the students are actively engaged. A sample "RSO Package" has been attached to this paper as an appendix.

By the end of the fall semester of 2023, STEM 4 Kids collaborated with the Consortium for Advanced Bioeconomy Leadership Education (CABLE), the Biomedical Engineering Society (BMES), the Society of Women Engineers (SWE), the Society of Mining, Metallurgy & Exploration (SME), the Chemistry Club, CSU's Little Shop of Physics, Alpha Sigma Kappa (ASK), CSU's Off-Road Racing Club, and CSU's 3D Printing Lab.

When working with other organizations, STEM 4 Kids offers to purchase supplies needed for the event as long as they are either consumables, kept by the students, or kept by STEM 4 Kids. Part

of hosting an event also includes coming to STEM 4 Kids' weekly meeting to go over the activity. This allows the officers and volunteers who attend to familiarize themselves with the activities and ask questions so that they can effectively help the students at the events rather than needing to figure the activity out themselves.

In addition to inviting other student organizations to lead an event, collegiate students are invited to volunteer at events that are planned by STEM 4 Kids. An email is sent out by the Volunteer Coordinator to our volunteer list. This list is formed throughout the semester by STEM 4 Kids members attending campus events such as the Welcome Week and various engineering events in which student organizations can promote their group and invite students to learn more about them. STEM 4 Kids volunteers can choose the event dates that work best for them. The STEM 4 Kids Volunteer Coordinator ensures that there is a balance between STEM 4 Kids leadership and the student volunteers at the event. The total number of collegiate students (leadership and volunteers) at the event is then balanced by the number of attendees for that night. Student volunteering is a form of community-based learning that STEM 4 Kids finds to be helpful to ensure a sufficient number of college students are helping the middle school students and to encourage the college students to build their skills as leaders and critical thinkers for the activities that they are helping with [7]. STEM 4 Kids has an average of four volunteers per event (not counting STEM 4 Kids leadership), often with four being there for the first half of the event and a different four rotating in for the second half.

Community Outreach and Advertisement

One of the most vital aspects of the success of the program is community outreach and advertisement. STEM 4 Kids leaders reach out to the middle school district science curriculum coordinator and to local math and science teachers to advertise the events to students and other faculty. Flyers are created for each new event that include a description of the two projects, the date and time, and a registration link. When parents or guardians register their student, they are asked for the student's allergies, parent contact information, event dates they are interested in attending, school and grade, and optional demographic information. This information allows contact with parents and guardians when necessary and in case of emergencies. It additionally lets STEM 4 Kids see what schools the outreach is working well with and who might need to be reached out to more.

To keep parents and guardians updated on program activities, a weekly newsletter relating to previous and future events is sent out. A flier for each new event is sent to the schools as well. While word of mouth is not the most reliable form of advertisement, many students will return to school and tell their friends and teachers about the events, which helps to increase attendance and

teacher support. In the future, there are plans to go to schools and pass out flyers to students directly to give a more in depth explanation of the program and show a demonstration.

On the other side of advertising, STEM 4 Kids reaches out to the engineering undergraduate student body to gain interest and increase our number of volunteers outside of the officer team as mentioned earlier. The leaders participate in campus wide student organization events such as student organization expos at the beginning of both semesters and engineering days in the spring semester. This lets collegiate students approach our booth to learn more information and generate more interest from engineering students and faculty as well. Including CSU events, a mass email is sent to CSU's engineering undergraduate student body one to two times a semester to advertise an initial informational meeting. In the past, STEM 4 Kids has also hosted social events with food and games, which enticed more engineering students to attend and learn more about signing up as a volunteer.

Parent and Student Response

Near the end of the first semester, STEM 4 Kids surveyed the students to determine if this program should continue into the next semester. The results from the students were not particularly conclusive, as the questions were open-ended, but the feedback received was primarily positive, which was encouraging. However, the most encouraging responses came from the parents. They would ask if STEM 4 Kids would be continuing the program and when. The most heartwarming was hearing stories about kids who do not normally talk about their school day, going home after an event and teaching their parents what they had learned at our program. The most common place for students to hear about engineering is from a family member [8], so having parent support is crucial for an organization like this.

Since the programming is focusing on middle school aged students, some students "aged out" after our first year. Depending on the growth of the program, STEM 4 Kids has plans to develop another program for high school aged students. However, the following year STEM 4 Kids had three students that "aged out" come back as volunteers to help the middle school age students. Seeing students return to the program to help inspire younger kids to pursue STEM felt like the events had helped make a change.

Conclusion

Creating an inclusive organization focused on increasing gender diversity and confidence in the STEM field has been a passion project for all of those involved. All of the volunteers and officers care about giving students this opportunity and enjoy being STEM educators. This

ultimately leads to a higher quality of events and a personal interest in contributing to participation and improvement. The formation of STEM 4 Kids has proved to be a long but worthwhile process. Since the fall of 2021, STEM 4 Kids' leaders have had the opportunity to learn from their own experiences and find ways to improve the structure and function of the organization as a whole. The biggest takeaways are that communication and feedback are the key to success. Communication between officers, volunteers, participating students, legal guardians, local schools, the engineering student body, and other organizations is vital to ensure that events run smoothly, STEM 4 Kids retains volunteers and participants, and the local community remains informed. Requesting feedback from legal guardians and students as well as reflecting amongst each other after each event lets us evaluate our events and ourselves. This allows STEM 4 Kids to ultimately continue to find more opportunities to grow and improve as an organization.

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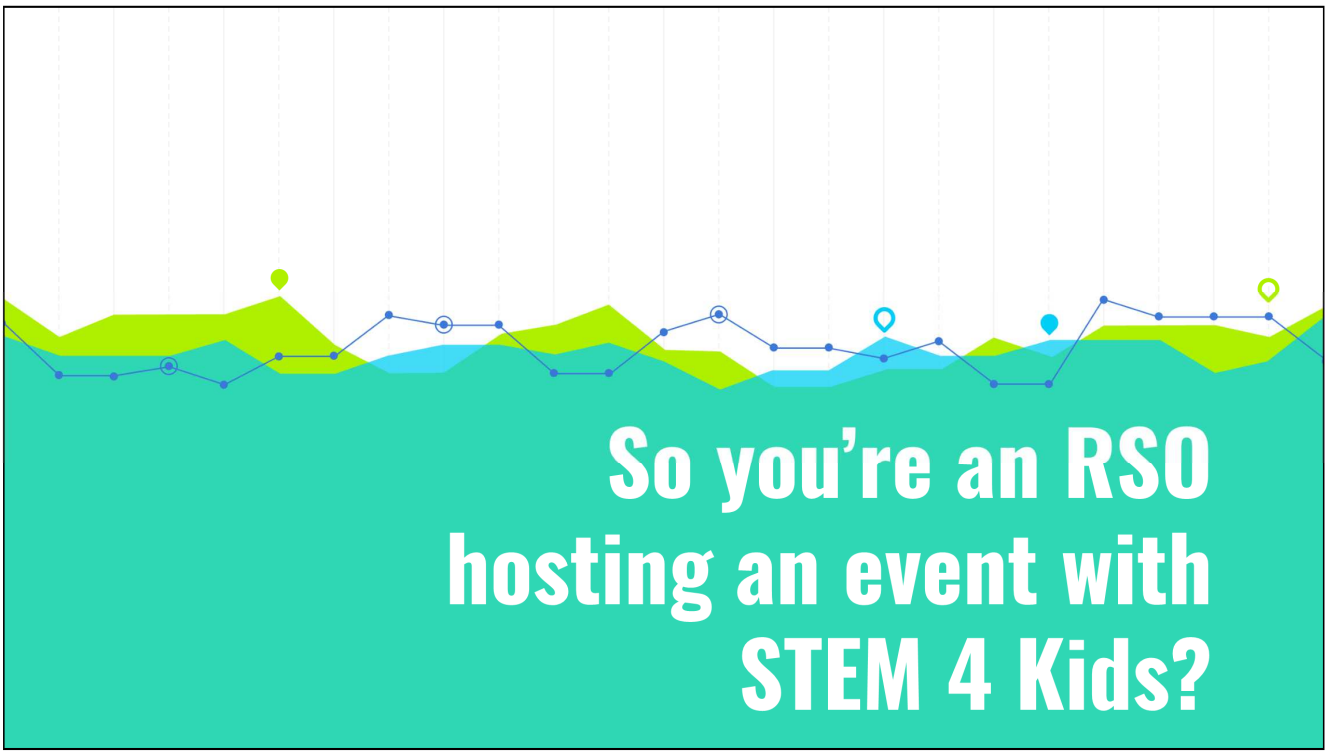
Appendix: RSO PowerPoint



Our Mission:

To introduce 4th-8th graders to fun hands-on engineering and science based projects in order to grow their confidence in the STEM field.

As a Hosting RSO:

Create an event that will be catered towards your RSO's area of concentration

Timeline of an Event

Bolded: RSO

Student Check-In

Ice Breaker/Team Building Activity (20 minutes)

Introduction to volunteers and activity (10-15 minutes)

Project #1

Italicized: S4K

Snack (15 minutes)

Project #2

Clean Up

Student Pick Up

Your Event:

- Project times are variable, these are just approximations of how long projects can take
- ***Events run 2.5 hours total with about 2 hours of activities***
- Please plan enough activities to fill the provided time

What we need from you:

- ❑ Names and emails of your **Volunteers**
- ❑ **Bill-of-materials**
- ❑ **Projects** complete with instructions/details on how the project will work
- ❑ **Ice-breaker activity** (optional)
- ❑ Presentation for the event
- ❑ Any and all questions you may have! We're here to help :)

3:10pm Volunteers Arrive
-RSO Volunteers
-S4K Volunteers
Set up room
-Table placement
-Prep Activities

4:00pm Students Arrive
-Start Ice Breaker Activities
-S4K can lead OR
- RSO can lead

Snack Break
-Snacks provided by S4K

Event Activity ≈ 2 hours

6:30pm Event Ends
-Clean Up
-Take Students to Pick Up

Volunteers

Due to the amount of time it takes to process a background check, we need you to send us the **names, emails, phone numbers, and student ID numbers** of everyone who plans on attending the event with you.

Send a *complete list* 2 weeks before your event. (Around 6 is ideal).

Send to: **volunteer.stem4kids@gmail.com**

We will send the background check, all you need to do is accept. Reach out ASAP if you do not receive an email from us within a week of sending us your volunteers list.

ALL VOLUNTEERS MUST COMPLETE A BACKGROUND CHECK TO PARTICIPATE

Bill of Materials

List what materials you will need us to purchase for you and a link to where we can get it.

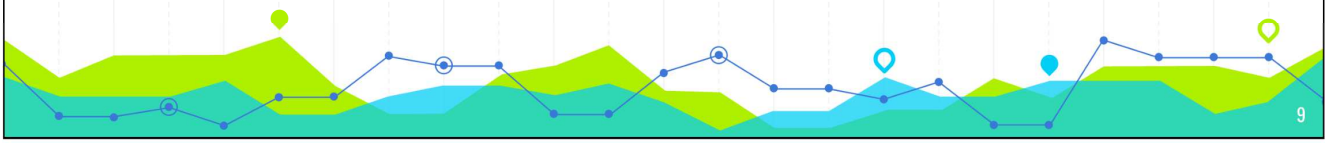
Please do not list materials you will be bringing yourselves as we don't want to buy more than we need.

S4K can help purchase materials your RSO ***isn't planning to keep.***

Amazon is quickest and easiest for us.

Your Projects

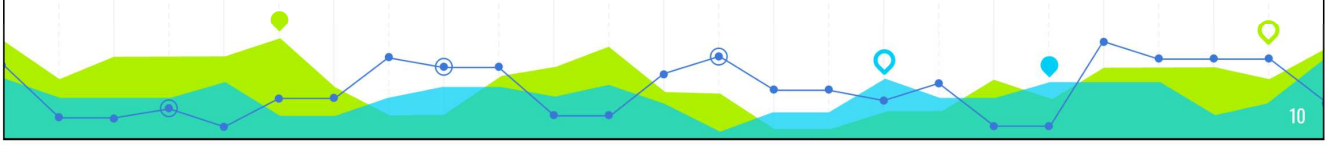
- Share with us a sheet that describes and has instructions for how to run the project for us to distribute to other volunteers.
- You should prepare a **powerpoint presentation** for the event that includes
  - A slide for each transition (ice breaker, project one, snack, project two, etc)
  - Instructions to help guide the students through the activities
  - Images/Videos/Lessons as needed



Your Projects

Keep in mind not to get too technical with lessons as these are middle schoolers and not college students

We want to these events to be more hands on than lecture based



Ice Breaker Activity

Activity/Team Builder

- Can be played as students arrive
- Anything from a name game to a Cup Stacking Competition
- Easy to keep PG-13

Stem 4 Kids is more than happy to run this part of the event! Just let us know, we have lots of ideas to pull from

What we need from you:

Once you know you volunteers and materials and have your activities presentation/instructions, please send them to us ASAP!

When we need it:

Volunteers/Materials sheet: 2-3 weeks before the event

Presentation: Tuesday before the event

Expectations

Tuesday, two days before event:

- RSO and its attending volunteers will join the S4K officers and volunteers for a meeting in Engineering Titan B203 from 3:30-4:30 pm to walk through the event slides and go through a brief training on working with minors

Thursday, day of event:

- Arrive at 3:30 to set up your activities
- Stay until 7:00 to help clean up

THANK YOU!

We're super excited for your event and are here to help you with anything you might need.

Sincerely,
S4K Officers