VEX EXP Teacher Facilitation Guide
Up and Over Unit

A Note about Implementing VEX EXP STEM Labs:
STEM Labs are designed to be an interactive Unit of instruction that you can use with your students to implement VEX EXP in your setting. STEM Labs are student-facing content that is designed for students to directly interact with the videos, resources, and instructional materials to complete the Lesson activities. This Facilitation Guide is the teacher-facing companion, like a teacher's manual, providing the resources, materials, and information needed to be able to plan, teach, and assess with VEX EXP. For more detailed information about implementing STEM Labs in your classroom, visit VEX PD+ for videos, expert tips, and more.

Unit Overview

In the Up and Over Unit, students will use the Controller to drive their Clawbot as they explore how to design, build, and iterate on a claw and arm for their robot, and learn about using motor groups to make their robot stronger, in preparation for an Up and Over competition. Students will use the engineering design process to iterate on their Clawbot build as they practice and iterate for the competition.

- In **Lesson 1: Introduction,** students will build the Clawbot and be introduced to the challenge of Up and Over.
- In **Lesson 2: Claw Design**, students will learn about what a claw is, how an effective claw works, as they practice moving Buckyballs with their robot. They will also learn about the concept of 'Scouting' and how scouting can benefit their team's design and strategy.
- In **Lesson 3: Arm Design**, students will learn about different elements of robotic arms, how they work, and what makes an effective arm as they practice stacking Buckyballs on rings with their robot.
- In **Lesson 4: Motor Groups**, student groups will learn about what motor groups are, and how they can be helpful; as well as how to configure a motor group in VEXcode EXP, as they practice lifting Buckyballs up and over a barrier on the Field. They will also learn about using data-driven decision making to choose a driver for their team in a fair and effective way.
- In the **Lesson 5: Up and Over Competition,** students will continue to use the engineering design process to iterate on their robots and game strategy as they prepare to compete in the Up and Over competition. In this competition, students will drive their robots to move Buckyballs into their scoring zone on the Field, to score the most points at the end of the match.
- The **Lesson 6: Conclusion** wraps up the Unit by introducing students to STEM careers related to the learning they did in this Unit, like Biomedical Engineer, then engages students in a debrief conversation to share their learning, and reflect on their experiences.

All Materials needed for this Unit can be found in the Master Materials List.

Teacher as Facilitator in this Unit

The Up and Over Unit is designed to be student-facing so that students can directly interact with the Lesson content. This places the teacher in the role of facilitator of learning, rather than a supplier of information, in the classroom. As such, you can choose how you want the students to move through

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the Lesson content, based on the needs and interests of your students, and the places where you think they may need more or less direct instruction.

When preparing to teach, decide how students will interact with the **Learn** section of each Lesson. Suggestions include:

- Whole class instruction - You can share the content in class alongside the Lesson Summary document, for whole group instruction, and facilitate conversations to check student understanding.
- Individual student instruction - If all students can access the content outside of class, you can have students read Lesson Summary and watch the Learn content as homework, then complete the CYU questions. In class, discuss the content and answer any questions.

When preparing to teach, decide how students will interact with the **Practice and Challenge Activities** in each Lesson. Step-by-step instructions are provided in linked Google docs within the Lesson content. Each Activity sheet can be edited to best meet the needs of your students. You may want to print those Activities out ahead of time and give them to your students, or project one in the classroom for all students to access at the same time.

This Facilitation Guide will offer reminders and tips for setup and modeling positive classroom culture for each Lesson. You know your students best, so tailor your teaching and Lesson implementation to best suit your students. The Up and Over Unit is designed to be flexible, so that you can meet students where they are, giving them the time, space, and instruction necessary to make the most of their learning.

Troubleshooting Tips for this Unit

- Be sure that your VEX EXP Brains, Batteries, and Controllers are ready to use. For more information on getting started with VEX EXP, see this section of the STEM Library.
- Students will need to have access to VEXcode EXP on their computers or tablets. For more information about installing VEXcode EXP, go to code.vex.com.
- Be sure that your VEXcode EXP firmware is up to date. To learn more about updating firmware, see this article.
- Students can use the built-in Help within VEXcode EXP, at any time to learn more about the commands they are using. For more information about accessing Help, see this section of the STEM Library.

Group Size and Student Collaboration

- A group size of 3 students per VEX EXP Kit is recommended for all Lab activities.
- For strategies to support student collaboration throughout this Unit, see this article.
    - Encouraging students to take ownership over certain responsibilities within their groups can help group work become a more student-led process, where all members of the group are participating and engaged in the Lesson.

Unit Vocabulary

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The suggested vocabulary for this Unit is meant to offer teachers a vehicle for establishing a shared language in the classroom when working with VEX EXP. Encourage students to work vocabulary words into their conversations throughout the Lab, so that they can use the terms confidently and correctly not only in this Lab but also in future VEX EXP experiences. You can use these words as a base list, and adapt them to best meet the needs of your students.

- **Claw -** a type of gripper that is used to pick up and transport objects
- **Scouting -** researching other teams so that you can make knowledgeable and informed decisions about your designs
- **Robotic Arm -** a mechanism or machine that functions similarly in motion to a human arm used to pick up, move, and transport objects
- **Motor Group -** consists of two motors that are going to function as if they are one device
- **Data-driven decision making -** using observable and measurable data to inform a decision

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Lesson 1: Introduction

Lesson 1: Introduction Overview

In this Lesson students will be introduced to the culminating competition game, Up and Over, build the Clawbot, and set up their engineering notebooks for this Unit.

Prepare Your Classroom:

Have the following spaces and materials ready prior to the start of class:

- An VEX EXP Kit for each group
- A charged VEX EXP Battery and Controller for each group
- Designated space to build the Clawbot for each group
- An engineering notebook for each student
- ***Optional***: A 'saving space' for groups to store their VEX EXP Kit and Clawbot for the duration of the Unit.

Reminders and Teacher Tips:

- **Reminder:** Be sure that your Controller firmware is up to date. To learn more about updating firmware, see this article.
- **To ensure that your students are clear on expectations for their engineering notebooks,** have a brief discussion after they watch the video to reinforce what students will be doing with their engineering notebooks in the Unit, and answer any questions they may have.
- **Engage students' prior knowledge** by facilitating conversations as they are building, and compare and contrast this build with those they have done previously.

Be Mindful of Mindset:

- **Set clear expectations for respectful collaboration** – Students will be working in groups to build the Clawbot. (For suggested roles for building the Clawbot, see this article.) Set clear expectations for how group work should function before beginning, to help ensure that all group members are engaged and working together in respectful ways.
    - Prepare students for the patience and persistence they will need in order to be successful with the build. Prior to building, have a conversation about things they can do as building is taking place to stay engaged and focused on the task at hand, by asking questions like:
        - What is something you can do while it is not your turn to build that would be helpful to the building process?
        - What is something that a teammate has done for you while you were building that helped you build more efficiently?
        - What are some things we can do to re-engage our brains if we feel ourselves getting distracted or losing focus?

    You may want to keep a running list of 'helpful ideas' generated in this conversation posted in the classroom, for students to refer to whenever they are engaged in collaborative building.

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Lesson 2: Claw Design

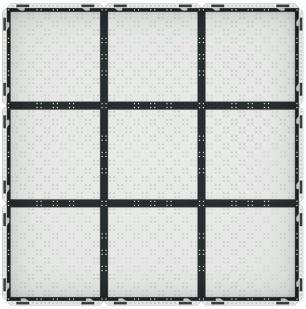
Lesson 2: Claw Design Overview

In this Lesson students will learn about what a claw is, how it works, and what makes an effective claw. In addition, they will be introduced to the concept of scouting, and how scouting can help teams develop their designs and strategy. They will explore these concepts by driving their robots with the Controller to pick up and move Buckyballs on a Field, to begin to prepare for the Up and Over competition.

Prepare Your Classroom:

Have the following spaces and materials ready prior to the start of class:

- A VEX EXP Kit for each group
- A charged VEX EXP Battery and Controller for each group
- A prebuilt Clawbot from the previous Lesson for each group
- A VEX EXP Field that is 3 Tiles by 3 Tiles with walls, as shown in the image below.



  - **Note**: If you do not have a Field, you can tape out a 90cm (~3 ft) by 90cm (~3ft) space on a floor or other flat surface.
- An engineering notebook for each student
- ***Optional***: A 'saving space' for groups to store their VEX EXP Kit and Clawbot for the next Lesson.
- **For Practice:** You will need 1 Buckyball to set up and complete the Improve Your Claw Practice Activity. You may also want to mark the red and green zones for easier identification.
- **For Compete:** You will need 3 Buckyballs, and a timer or stopwatch, to set up and complete the Grab and Go Challenge Activity. You may also want to mark the red and green zones for easier identification.

Reminders and Teacher Tips:

- As students are learning about types of claws, and practice manipulating the Clawbot to move Buckyballs, facilitate conversations to engage their prior knowledge, and draw on their experiences with remote control driving, or claw manipulators in real life.
- **Teacher Tip:** The concept of scouting may be unusual to students, and they may have the instinct to be protective over their work. **The goal of scouting is for students to take on an active role in learning from and with their peers.** If a student sees a claw iteration that works, and brings it back to their team, and the team can successfully build that claw – that is active learning. If students can successfully recreate a design for themselves, that means that they understand that design and how it works.

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    - To help students gain comfort with this process, you may want to take time to have a conversation about what scouting means in your classroom.
        - Ask students how they feel about this idea, and what (if any) parameters they may want to set for themselves to help them scout with intention.
        - Make a list of prompts or things to ask about, or even role play scenarios to make sure that students are comfortable with the scouting process, so that they can begin to use it effectively.
- To ensure that all students have an opportunity to practice driving and manipulating the Clawbot to move the Buckyball, allow as much class time as needed for all students to complete the Practice Activity.
- **Teacher Tip:** If your students need more practice with driving the robot confidently, you may want to add rounds to your challenge competition, so that each team member can participate. You can determine how you will choose a winner, like averaging times together, or drop the slowest time, etc.
- **Reminder:** Remind students that they can document driving 'tips' or preferences in their engineering notebook, like which buttons control which part of the robot, so they can refer back to those notes during future challenges.
- **Reminder:** Remind students that they are beginning with the Clawbot, and are **iterating to build a new claw** that can better grasp and move Buckyballs. They should be documenting the process as well as the product of their claw design. Some prompts to facilitate this include:
    - **Document the process of design** - What ideas did you have/combine to reach consensus on one?
    - **Document each iteration** - You started with the Clawbot, what did you change first, second, third… to get to your new claw?
    - **Document success and failure** - What happened when it didn't work? How did you identify and address the problem? How did you make your design more successful?
- To learn more about running Challenge competitions, including logistics and setup, see this article.

Be Mindful of Mindset:

- **Frustration is natural, and it is ok –** It may take students several attempts to successfully move Buckyballs with their robot. This may incite a wide range of emotions in students. This is not only ok, it is encouraged! Help students to lean into the iterative process, including the potential frustration that can arise when they are not instantly successful. Celebrate perseverance, and highlight groups that tried repeatedly, worked together, and maintained focus through the frustration.
    - **What was your 'Focus Over Frustration' moment today?** One way to do this is to wrap up class with a moment to have students articulate for themselves the strategies they used to help them learn from their mistakes and persist, even when they felt frustrated or disappointed.

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VEX EXP Teacher Facilitation Guide
Lesson 3: Arm Design

Lesson 3: Arm Design Overview

In this Lesson students will learn about robotic arms, including types of arm construction, and how to create an effective arm to make a robot complete a task. Students will practice using the arm on the Clawbot to lift Buckyballs and stack them onto rings, as they prepare for the Up and Over competition.

Prepare Your Classroom:

Have the following spaces and materials ready prior to the start of class:

- A VEX EXP Kit for each group
- A charged VEX EXP Battery and Controller for each group
- A prebuilt Clawbot from the previous Lesson for each group
- A VEX EXP Field that is 3 Tiles by 3 Tiles with walls, as used in the previous Lesson
    - **Note**: If you do not have a Field, you can tape out a 90cm (~3 ft) by 90cm (~3 ft) space on a floor or other flat surface.
- An engineering notebook for each student
- ***Optional***: A 'saving space' for groups to store their VEX EXP Kit and Simple Clawbot for the next Lesson.
- **For Practice:** You will need 1 Buckyball and 1 ring, to set up and complete the Improve Your Arm Practice Activity. You may want to mark the Buckyball/ring locations on the Field.
- **For Compete:** You will need 5 Buckyballs of any color, and a timer (optional), to set up and complete the Stacked Up Challenge.

Reminders and Teacher Tips:

- **Teacher Tip:** For the 60 second matches, you can either use a timer or stopwatch, or have students use the 'Run for 1 minute' selection for the Driver Control program on the Brain. Be sure that both drivers start their projects at the same time, so that they run for the same time.
- **Reminder:** Remind students to document the results of their Practice trials, so that they will have data about driving skills to use as they prepare for the Up and Over competition.
- **Teacher Tip:** You may find that there are varying degrees of building success across your class. This is a great opportunity to empower your students to learn from and with one another. Have frequent whole class check-ins, where students can ask and answer each other's questions as they are building and testing their robot designs.
- **Reminder:** Students are once again beginning with the Clawbot, and are **iterating to build a new arm** that can better lift and move a Buckyball onto a ring. They should be documenting the process as well as the product of their arm design. Some prompts to facilitate this include:
    - **Document the process of design** - What ideas did you have/combine to reach consensus on one?
    - **Document each iteration** - You started with the Clawbot, what did you change first, second, third… to get to your new arm?

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    - **Document success and failure** - What happened when it didn't work? How did you identify and address the problem? How did you make your new arm more successful than the original Clawbot?
- **Teacher Tip**: Students are beginning with their design from the previous lesson, and working with that claw design as they iterate on the arm. Make sure that students are considering how their claw design will affect their arm design (and vice versa) and are not thinking about the arm and the claw as completely separate entities.
    - As they are documenting their process in the engineering notebook, students should note things like:
        - Does the arm work with their claw?
        - How does their claw impact their arm design choices?
        - If the arm is unsuccessful, how did they identify and address the problem?
- You may want to have additional Buckyballs and rings available for students to use as they are building and testing their robot arms, so that the Practice area can stay accessible for all students.
- **Reminder:** Remind students that their engineering notebooks are designed to be unique to them, and do not need to be perfect. Give options for how to document learning, like sketching or printing photographs of the Clawbot, different arm constructions, or claw designs; or offer the class a Field Setup image that they can glue or copy into their notebooks.
- To learn more about running Challenge competitions, including logistics and setup, see this Knowledge Base article.

Be Mindful of Mindset:

- **Highlight Scouting to encourage the practice –** As students are iterating on their builds throughout the Lesson, encourage them to look to other groups' builds and iterations for inspiration. Students learn within their groups, as well as from and with other groups in the class. By highlighting positive scouting experiences, you can dispel any negative associations students may have, while building their capacity for problem solving, thinking flexibly, and genuine collaboration.
    - One way to do this is by having a **'Clawbot Show & Tell'** time, where groups share their builds with one another, explain their design process and the rationale behind their choices, and answer questions about how it works. Have students document what they learn, and what ideas it prompts in their engineering notebook, to set them up for success as they move into the Up and Over competition.

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VEX EXP Teacher Facilitation Guide
Lesson 4: Motor Groups

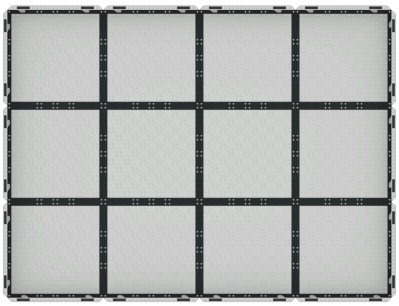
Lesson 4: Motor Groups Overview

In this Lesson students will learn about what a motor group is, the advantages of using a motor group, and how to configure a motor group in VEXcode EXP. Students will also learn about data-driven decision making in the context of choosing a driver for a competition. Students will practice driving their robot to pick up and move Buckyballs over a barrier on the Field, as they prepare for the Up and Over competition.

Prepare Your Classroom:

Have the following spaces and materials ready prior to the start of class:

- A VEX EXP Kit for each group
- A charged VEX EXP Battery and Controller for each group
- A prebuilt Clawbot from the previous Lesson for each group
- 2 VEX EXP Fields that are 3 Tiles by 4 Tiles with walls, as shown in this image to the right.
    - **Note**: If you do not have a Field, you can tape out 2 90cm (~3 ft) by 120cm (~4 ft) spaces on a floor or other flat surface.



- Set up two 3’ x 4’ Fields and push them together so they create a 4’ x 6’ Field with a barrier in the middle as shown in the Up and Over Challenge document.
- An engineering notebook for each student
- ***Optional***: A ‘saving space’ for groups to store their VEX EXP Kit and Clawbot for competition.
- **For Practice:** You will need 5 Buckyballs to set up and complete the Over the Barrier Practice Activity. You may want to mark the Buckyball locations on the Field, for easy setup.
- **For Compete:** You will need 6 Buckyballs of any color, and a timer or stopwatch, to set up and complete the Up and Over Challenge.

Reminders and Teacher Tips:

- **Reminder:** Remind students to document their conversations and ideas in their engineering notebooks as they continue to engage in scouting, so that they can get a complete picture of how their design evolved.
- **Teacher Tip:** Encourage students to iterate on their robots to test out the efficacy of using motor groups in different locations, and for different functionality.
    - Students may make incorrect assumptions about how a particular design will function as they move through the engineering design process – that is ok, and is a valuable part of learning. Students will likely make more lasting connections if they are able to identify and correct their misconceptions through their own practice, rather than simply being told what may or may not work.

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- You may want to have additional Buckyballs available for students to use as they are building and testing their robot arms, so that the Practice area can stay accessible for all students.
- **To further support students as they are getting started with VEXcode EXP**, you can use the following resources:
    - For help with pairing the Brain to VEXcode EXP, see this section of articles.
    - For help with opening and saving projects, see these device-specific articles.
    - For help with downloading and running projects, see this article.
    - For help with connecting the Controller see this article.
- **Reminder:** Remind students that they will be using the engineering notebook data to help them choose a driver in the competition lesson, so be sure that they are noting unbiased information and measurable data during the practice and challenge activities to help inform those decisions.
- To learn more about running Challenge competitions, including logistics and setup, see this STEM Library article.
- **Teacher Tip:** You will use the same Field setup (with the barrier) for the Up and Over Competition, so you can keep the setup intact in preparation for the next Lesson.
- **Teacher Tip:** You may want to have some predetermined decision making strategies (like rolling a die, or flipping a coin) for students to use if they have similar data sets when making a decision.

Be Mindful of Mindset:

- **There is no such thing as "I'm done." –** There is always something that can be further iterated on in a STEM Lab Unit. Students can revisit previous decisions they made about their robots, they can add to their engineering notebooks, they can test different driving strategies, and more. The goal of these Lessons is not to create the 'perfect' robot – it is to continue to learn through iteration. As such, iteration is never complete!
    - If students say that they are 'done' during class, have them continue to iterate on a component of their robot or driving strategy, like the robot's claw design, and document any changes and the rationale behind them in their engineering notebook.
    - Students can also be doing different roles in these moments - one may be scouting for iteration ideas, while another sketches a design idea, and the third practices driving and manipulating the Buckyballs more quickly.

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VEX EXP Teacher Facilitation Guide
Lesson 5: Up and Over Competition

Lesson 5: Up and Over Competition Overview

In this Lesson students will apply what they learned to compete in an Up and Over classroom competition!

- Teams will compete in a 60 second, one-on-one match to drive their robots to move Buckyballs over the barrier into their scoring zone. Buckyballs have different point values based on their color, and points will be tallied at the end of the match. The robot with the most points in their scoring zone wins. First, students will have an opportunity to develop a game strategy and iterate on their Clawbot, then they will compete in the competition.
- **To learn more about running a classroom competition, like logistics and setup**, see this article.
- **To learn more about facilitation strategies for classroom competitions**, see this article.

Prepare Your Classroom:

Have the following spaces and materials ready prior to the start of class:

- A VEX EXP Kit for each group
- A charged VEX EXP Battery and Controller for each group
- A computer or tablet with access to VEXcode EXP for each group.
- A prebuilt Clawbot from the previous Lesson for each group
- 2 VEX EXP Fields that are 3 Tiles by 4 Tiles with walls, pushed together to create a 4' by 6' Field for the Competition Matches (as in the previous Lesson)
    - **Note**: If you do not have a Field, you can tape out 2 90cm (~2 ft) by 120cm (~4ft) spaces on a floor or other flat surface.
- An engineering notebook for each student
- A 'practice space' for teams to practice and refine their strategy and code as they get ready to compete.
- 'Team meeting' spaces, for teams to meet together, to iterate on game strategy and their robots and code.
- ***Optional:*** Labels for each space in the classroom, with notes on the board for students to reference as they move through the room during the Competition
- A match schedule and leaderboard
    - To learn more about running a classroom competition, like logistics and setup, see this article.
- A timer or stopwatch (optional)

Reminders and Teacher Tips:

- Encourage students to use the match schedule to set parameters and time limits for teams' iterations between matches.
- You can use the Up and Over Competition Activity Document to print or project and share with students throughout the Lesson.

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- **Reminder:** Remind students that the engineering design process should be applied many times throughout the competition. In their teams, they should choose one thing at a time to iterate on, and document the changes, the test results, and the implications in their engineering notebooks.
- If students are struggling to identify a starting point for the engineering design process, ask questions to get them thinking, like:
    - **How is your team's driver strategy** going to help you in the competition? Is there anything you could change about the Buckyballs you are moving, or the order in which you move them, to optimize your score?
    - **How is your robot optimized** for this competition? Is there anything you could add or change about your claw or arm to make your robot move Buckyballs more efficiently?
    - **How is your team's game strategy** setting you up for success? How will you make best use of your time in the match to optimize your score at the end of the match?
- **Teacher Tip:** During the competition and engineering design process, students may make changes to their robots or game strategy that will be unsuccessful - that is ok. Give students the space to make mistakes and to learn from those mistakes, so that they can engage in authentic problem solving and evidence-based iteration.
- To learn more about facilitation strategies for classroom competitions, see this article.

Be Mindful of Mindset:

- **Balance the voices within and amongst teams** – It is sometimes easy for the 'loudest voice' in a group to take control over decision making or strategy. Ensure that your teams are following through with the data-driven decision making and respectful communication practices that were discussed in the Lesson 4 Learn video.
    - There are many different game strategies that can be used in this competition, so give teams time and space to test out multiple ideas and perspectives to ensure that they have the data needed to reach consensus.
    - To help ensure that **all** members of the team can speak to their shared game strategy, circulate around the room as students are working, or have them check in with you, and ask questions like:
        - Can everyone on your team explain your driver strategy to me? How did you come to a consensus about your driver? What data did you use to make your decision?
        - How is your robot design setting your team up for success in the competition? Can you show me how you have documented your strategy so far? What data will you look for during the match to let you know that your design is effective?

- **Continue to reward process over product –** In a competition like Up and Over, students may fall into the default mindset that only one robot in the class is successful.
    - To help keep the process over product mentality alive throughout the competition reward students for unique robot designs, risk taking throughout the Unit, strong group work, persistence and perseverance, collaboration, communication, and more.
        - This can be in the form of 'superlative' certificates, or a non-tangible reward like having an extra privilege in class. You know your students best, so tailor your positive reinforcement accordingly.

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VEX EXP Teacher Facilitation Guide
Lesson 6: Conclusion

Lesson 6: Conclusion Overview

In this lesson, students will reflect on their learning and experiences in the Unit, to share their learning with the class and see how that connects to various career paths.

Facilitating Career Connection

- **Make It Personal** - There are two career connections offered in the Unit, but you can adapt those to offer different career connections that may be better suited to your students. If you know someone that works in a related field, or your students have expressed interest in a particular career path that relates to the Unit, find ways to incorporate those personal connections to deepen students' engagement.

- **Facilitating the Choice Board -** Consider how you want students to interact with the Choice Board. The goal of the Choice Board is to give students an opportunity to express voice and choice in their learning, so think about the following as your plan your lesson:
    - Will students choose activities individually or in their groups?
    - When and how will students complete the task?
    - How will they share their learning?
    - Can students complete more than one Choice Board activity?

  The Choice Board can also be adapted with activities that are better suited to your students.

Facilitating the Debrief Conversation

- **Be Mindful of Mindset:** Meaningful student self-assessment can only occur if students feel comfortable and confident that they can be honest and vulnerable without being penalized for it. Be cognizant of your teacher language as you talk about progress and mistakes or misconceptions throughout the Unit. How you are engaging with students throughout your class time will lay the foundations for self-assessment that genuinely reflects and supports students' learning.

- **Organize Debrief Conversations** - You may want to set up a schedule so that students can sign up for debrief conversations as they are ready. Be sure that students have access to the rubric that will be used for the Debrief Conversation. (These rubrics are editable Google docs, that you can customize to meet your needs and the needs of your students.)

- **Conclusion Activities -** Make sure that students have something to do while they are waiting for their debrief conversation with you. If students finish their self reflection early they can:
    - **Add to their engineering notebook** - Continue to document their final build with images or sketches, journal about the competition experience, or add to their self-assessments.
    - **Clean up from Competition** - If you do not want students to bring their robots to the debrief conversation, they can begin to take them apart and put the pieces away.

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- **Build a Bulletin Board** - Have students create a bulletin board space that reflects their learning throughout the Unit using elements from their engineering notebooks.

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