# Impact of an After School STEM Service Learning Course on Undergraduate Students (RTP)

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## Abstract

Exposure to pre-college Science, Technology, Engineering, and Mathematics (STEM) activities and undergraduate service learning have been linked to increased interest and participation in STEM careers. However, few studies have linked these two activities to increased interest and participation in teaching careers related to STEM. Due to changing national standards and demographics, the next generation of K-12 teachers will be required to integrate STEM into their classrooms while dealing with students of diverse backgrounds that may differ significantly from their own. Of concern are the elementary or K-6 teachers who will be expected to include STEM in their lessons but do not hold an undergraduate degree in a STEM field and may not even be familiar with the acronym. This preliminary study evaluates the impact of an After School STEM service learning course on undergraduate preservice teachers (PSTs). This course was designed with the broad goal to engage undergraduates who are thinking about becoming teachers (going on to a credential program after graduation) in a service learning course in which they engage in a pre-credential field experience. As part of this experience, undergraduates learn about STEM integration in teaching and STEM based activities, and then teach those activities to elementary students in local after school programs. The main research questions for this study include: A) How did the service learning experience (in which our undergraduate students teach STEM activities in elementary after school programs in diverse communities) influence their ideas about: (1) STEM, (2) teaching elementary students about STEM, and (3) teaching diverse populations of students?, and B) Were there differences in these ideas depending upon the elementary school site where the service learning practicum took place? The undergraduates' experiences and developing perspectives are examined through written reflections and field observations throughout the semester. Instructors' field notes from the service learning experience are used as a data source of triangulation. In general, results from this study indicate that undergraduate students' ideas about STEM and STEM teaching strategies changed, perception of young students' abilities to engage in STEM were expanded, and self-confidence and desire to pursue a teaching career increased.


## Introduction

With the growing demand for Science, Technology, Engineering, and Mathematics (STEM) workers and the lack of diversity found in the United States STEM labor force (Xue & Larson 2015, Funk & Parker 2018), there is a need to both increase and plug the leaks in the STEM workforce pipeline (Chen 2013). To increase the number of students interested in STEM careers, K-12 educators have begun introducing STEM activities to more diverse and younger audiences through after school programs (Krishnamurthi et al. 2014). This demand for STEM workers has also led to the inclusion of engineering in the latest K-12 science standards, the Next Generation

Science Standards (NGSS), which have been adopted by 19 states (NGSS; NGSS Lead States 2013). To help mitigate leaks in the pipeline, service learning has been used at the undergraduate level due to reported positive impacts on overall performance and persistence of students, particularly those who are underrepresented (Song et al. 2017, Hayford et al. 2014).

While this need to introduce STEM to younger and more diverse audiences has begun to change the landscape of teaching at the elementary level, teacher preparation programs are grappling with the task of providing pre-service teachers (PSTs), particularly K-6 educators with little or no background in STEM disciplines, with the skills needed to succeed. Two key components of this new way of teaching science that elementary teachers need to be prepared to do are: (1) integrating STEM in their classroom and (2) teaching students of diverse backgrounds, which may be very different from their own.

*Integrating STEM*

Given the new vision of science education as presented by the *Framework for K-12 Science Education* (NRC 2012), much more is expected of new teachers and, consequently, educators who prepare new teachers in their credential programs. Many elementary PSTs typically have little to no experience with science, let alone engineering/technology, and enter the teaching profession feeling unprepared to integrate the two (Banilower et al. 2013). More experiences are needed for PSTs to have the opportunity to *practice* integrating STEM with real elementary students, beyond a science methods course and even before beginning a credential program. Informal learning environments that use hands-on STEM experiences have been shown to increase STEM confidence and self-efficacy in pre-service elementary teachers (Adams et al. 2014). A place where PSTs may have the opportunity to get this practice, as they learn about STEM integration, is in a service learning course that uses informal learning environments.

*Working with Diverse Populations and the Potential of Service Learning*

Service learning is an instructional approach that centers on partnerships between classrooms and community organizations. What results is a mutually beneficial relationship in which students learn to apply theory in a real-world context while learning more about and helping their community, and community partners receive support in areas of need. In the case of teacher education, service learning usually takes the form of PSTs enrolled in a course during their preparation program engaging in service at schools within their community. Research has suggested that service learning can be a powerful strategy when incorporated as part of field experience in elementary teacher education programs, benefiting PSTs, as well as partner K-6 teachers and their students (Bush & Cook 2016, Wilson et al. 2015).

PSTs often enter credential programs with stereotypical beliefs about students' abilities to learn, which can inhibit them from providing equitable learning opportunities (Sleeter 2005). In addition, a large number of teachers in the United States leave their credential programs feeling unprepared to teach students from diverse backgrounds (Banilower et al. 2013). Service learning can act as one way to challenge PSTs' beliefs about diverse students (Cone 2009) as well as themselves (Wilson et al. 2015).

Through a service learning experience, students can (1) bridge theory with practice, (2) help address issues in the local community, and (3) use their growing knowledge to respond to social problems. For PSTs who are not yet in a credential program (considering a career in teaching) and have little teaching experience, it gives them a chance to "try out" teaching and at the same time apply ideas they are learning about and better reflect on these ideas in their coursework. Particularly in after school programs, service learning can give PSTs an opportunity to try teaching in a low-stakes environment, and can help them gain a better understanding of the community in which they live and/or will be working with.

## Research Design

### *Research Questions*

In order to address the above challenges, an undergraduate course was designed with the broad goal to engage undergraduates who are thinking about becoming teachers (going on to a credential program after graduation) in a service learning course in which they engage in a pre-credential field experience. As part of this experience, undergraduates learn about STEM integration in teaching and STEM based activities, and then teach those activities to elementary students in local after school programs.

The authors set out to explore the following research questions regarding the impact of the course on its students:

- How did the service learning experience (in which our undergraduate students teach STEM activities in elementary after school programs in diverse communities) influence their ideas about: (1) STEM, (2) teaching elementary students about STEM, and (3) teaching diverse populations of students?
- Were there differences in these ideas depending upon the elementary school site where the service learning practicum took place?

### *Course & Participants*

Seventeen undergraduate students enrolled in the After School STEM Practicum Course during the Spring 2018 semester participated in this study. All participants were enrolled as undergraduates in a large public university in the Western region of the United States, but varied in their academic year (2 sophomores, 4 juniors, and 11 seniors). Participants were primarily female (16 female, 1 male) and liberal studies majors (16 liberal studies majors; 1 engineering major). A majority of the students (11) stated on the first day of the semester that they had already planned to apply to a multiple subject (elementary) teaching credential program after graduation and the rest reported that they were considering teaching as a career.

The course was taught during this semester by one of the authors, who also teaches elementary science methods at the same university. During the 15-week semester (Table 1), students participated in the course twice per week (Tuesday and Thursday) for approximately two hours each day. For the first three weeks, students met on the university campus on both Tuesday and Thursday to learn about instructional strategies and participate in the activities that they would be teaching their elementary students. Students were also introduced to information about the context of the after school programs and the communities in which the participating elementary schools reside by program directors from the county office of education. At this time, each student was assigned to one of six after school classes at two local elementary schools, in which they remained for the rest of the semester (Table 2).

**Table 1. Overview of course structure**

<table>
<tr><th></th><th>Weeks 1-3</th><th>Weeks 4-5</th><th>Weeks 6-8</th><th>Weeks 9-11</th><th>Weeks 13-15</th></tr>
<tr><td>Tuesday</td><td rowspan="2">On Campus<br>• Engage in STEM activities<br>• Engage with and discuss pedagogy strategies<br>• Form groups and sign up for after school classes</td><td>After School Classes<br>Structured observations</td><td>After School Classes<br>STEM lessons<br>Topic: Flight & Rocketry</td><td>After School Classes<br>STEM lessons<br>Topic: Architectural Engineering</td><td>After School Classes<br>STEM lessons<br>Topic: Force & Motion</td></tr>
<tr><td>Thursday</td><td>On Campus<br>• Debrief observations<br>• Plan lessons</td><td colspan="3">On Campus<br>• Debrief teaching experiences<br>• Engage in STEM activities<br>• Plan lessons</td></tr>
</table>

**Table 2. Summary of after school class characteristics**

| School | School Characteristics | Grade Level | # Elementary Students | # University Student "Instructors" |
|---|---|---|---|---|
| Elementary School #1 | 60% "low income"<br>43% white, 29% Hispanic, 15% black<br>5% EL | 2nd | 22 | 3 |
| | | 3rd | 21 | 3 |
| | | 5th | 19 | 2 |
| Elementary School #2 | 88% "low income"<br>38% Hispanic, 33% white, 14% black<br>31% EL | 1st/2nd | 20 | 3 |
| | | 3rd/4th | 23 | 3 |
| | | 5th/6th | 20 | 3 |

During the fourth and fifth weeks of the semester, students spent about an hour on Tuesday observing their assigned class of students in the after school programs during their regular activities, led by their regular instructor. These observations were structured by an observation protocol and were debriefed on Thursday during their course meeting on the university campus.

For the remaining nine weeks of the semester, the undergraduate students met on the university campus with the course instructor on Thursdays to continue to engage in and learn about the STEM activities they would be teaching to their students and debrief the lessons they had already taught. Time was also spent in class learning about STEM itself and its role in education as well as introductory material about strategies for managing student discourse, assessment, and co-teaching strategies.

During these last nine weeks, the undergraduate students in the course taught STEM activities on Tuesday afternoons 3:30 – 4:30pm to their assigned classes. STEM activities were bundled into three 3-week-long “units”: (1) Flight and rocketry, (2) Architectural engineering, and (3) Force and motion (see appendix). The basic activities were provided in class, but groups of undergraduate students worked together to adapt them for their particular group of students. Groups worked together to write daily lesson plans using a template provided by the instructor, and turned in those plans before the beginning of each unit for feedback from the instructor. During the teaching of their lessons, the instructor and two after-school program directors from the county office of education rotated to observe the teaching of the STEM activities in all classrooms, take field notes, and provide feedback to the undergraduate instructors.

*Data Collection*

A variety of reflections written by the undergraduates were collected throughout the semester (see appendix for reflection prompts). Before working with elementary students, participants were asked to respond in writing about their initial assumptions/expectations about (1) STEM, (2) the course, and (3) the elementary students to whom they would be teaching. Throughout the semester, students completed several <u>practicum</u> and <u>service learning</u> reflections. Practicum reflections focused on their teaching while the service learning reflections focused on their experience in the community.

In addition to participants’ reflections, the course instructor and two after school program directors from the county office of education recorded field notes during their observations of the participants teaching in the after school programs.

**Preliminary Results**

The written reflections from Spring 2018 have been analyzed using Grounded Theory's Open

Coding (Strauss & Corbin 2008), in which common themes among responses are identified and coded to determine emerging patterns in the data. Since this study is still ongoing as of Spring 2019, only a preliminary analysis, including a first read-through of participants' reflections and identification of potential themes has been performed. As additional data is collected each semester, themes and sub-codes will be established and defined. Once codes are established, to ensure inter-rater reliability at least two researchers will code the reflections independently and discrepancies in coding will be resolved through discussion. Patterns in these codes will be examined within the same time (e.g. what commonalities in perceptions are seen among all participants in their pre-reflections, before they began working with elementary students?) and across time (e.g. what patterns of change are seen for participants in their pre-reflections versus mid-reflections and post-reflections). The authors are also comparing data between school sites (e.g. Do the patterns of codes that are seen for participants working with students at elementary School #1 vary from the participants at School #2?). In order to explore possible reasons for these differences, instructors' field notes from the service learning experience will be used as a data source of triangulation.

*Views on STEM*

On the first day of class, less than half of the students were able to identify the meaning of the letters in the STEM acronym. Those who tried to go beyond spelling out the acronym to describe STEM as a discipline showed misconceptions about STEM integration. For example, students wrote: "[STEM is] a program that K-8 students have the option of being a part of" and "STEM is a program or specific section of education/teaching that focuses solely on science and mathematics."

By the end of the semester, every student correctly identified the four words in the acronym and over a third attempted to explain how the four disciplines integrate together. For example, students wrote "Engineers use science and math to create technologies." And "All of these components are essential for making sense of the world and so we can produce technologies to solve problems." Participants also commented on the course increasing their interest in STEM and helping them to recognize how they use STEM in their everyday lives.

One student wrote: "At the beginning of the semester I only thought of the science portion of STEM and I have realized that there is much more to it. I have a better idea of how all of these ideas relate and can be used in younger grades. I have become more interested in STEM and realizing that I use the concept of STEM in my day-to-day life."

*Views on Teaching STEM*

In their reflections at the beginning of the semester, many of the undergraduate students expressed that they were excited to teach, but reticent to teach STEM due to their lack of knowledge and experience in these subjects. Many of them described “engagement” in STEM as being when the students are quietly listening to the teacher and paying attention. Many students indicated that they were worried about managing the hands-on activities that were planned. Students also expressed confusion regarding how they would incorporate engineering and technology in the classrooms “without computers” and wondered if the elementary students would be able to successfully complete the engineering challenges given that they were “so young.”

An initial read-through of the reflections at the end of the semester indicate an overall positive shift in the way that the undergraduate students describe how STEM should be taught at the elementary grades. Responses reflect an overall more positive attitude about what elementary students are able to accomplish. For example, one student wrote: “I thought that STEM was just for advanced students. Now I know that all students can thrive in STEM. I also know that STEM is helpful for students to learn their interests.” Participants also described STEM teaching as much more inquiry-based, where students work together to solve problems. One student wrote: “You don’t need fancy computers for STEM. Just a good problem that kids want to solve.”

*Views on Teaching Diverse Students*

Initial reflections undergraduates wrote about their expectations for working at their school sites (before beginning their practicums) reveal a common theme of anxiety about what their students will be able to do, especially for something “as complex as STEM.” The undergraduates were also concerned about classroom management and teaching in a “bad neighborhood”

Final reflections show an overall positive attitude toward the community, influenced by the service learning experience. For example, when asked if the experience made them think differently about the community, undergraduates responded:

> “Yes, I was really nervous about teaching in [this community] in general because I have heard students can be tough. However, I really enjoyed teaching in [this community] and the students have just as much potential as anywhere else.”
>
> “Yes! These students completely surprised me! I thought that they would be too rowdy and it would be hard to teach them. I found that these students were kind and appreciative and work really hard.”
>
> “These kids were amazing and they blew me away with their creativity! They are extremely smart and have unique ways of problem solving.”

*Differences based on Service Learning Site*

Not all comments from participants at the end of this preliminary study were positive. There were three students who included pessimistic comments in their final reflections, indicating that they still held doubts about the feasibility of teaching STEM to young students, especially in the local community. For example, students wrote: "Our community is struggling. Lots of broken families. This is the future of our country." And "I learned that not all kids can do STEM. These kids are too young to do some of this stuff. You just have to tell them sometimes."

While there is currently not a sufficiently large sample to make generalizations, it is interesting to note that all three of the students who indicated such "pessimistic" comments completed their practicum at School #1. Field notes from the instructor and other observers indicate that, while conditions at School #2 remained stable throughout the semester, classes in the after school program at School #1 changed classroom locations multiple times. Additionally, while the site coordinator at School #2 had been in that role for eight years, the site coordinator at School #1 changed three times during the semester in which our students were completing their practicum, contributing to an overall feeling of instability and lack of organization from the leadership at that site.

As the authors continue this study across multiple semesters of students and increase the sample size, further comparison of experience between the two schools will be explored in order to enable future generalizations. Identifying what aspects of each site may be helping or hindering students to grow and have positive experiences with teaching STEM and/or diverse students will enable the successful adoption and implementation of similar courses at other universities.

**Conclusion**

It is clear from this preliminary study that student perceptions of teaching STEM and working with diverse communities can be challenged and expanded to better prepare them as K-6 educators.  Preliminary data indicates that students finish the course with a better understanding of STEM and their ability to integrate STEM into activities for young audiences. Preconceived notions regarding the ability and behavior of students based on their age and socio-economic backgrounds or race/ethnicity were reevaluated by participants which will hopefully influence their willingness and ability to work at a diverse school as they enter the teaching profession. Additional data is being collected each semester to enable this methodology to be adaptable or generalizable to other universities.

Additional studies will continue to address the above questions as well as look at longitudinal behavior of participants. Of particular interest are the long-term impacts on participants in this course who continue into teaching credential programs after completing their undergraduate degrees.  For example, as these students continue their training to become teachers, the authors plan to explore whether they persist longer than their colleagues in institutions with diverse student populations, if participants report feeling more prepared to meet NGSS standards, and if participants report feeling more prepared to work with diverse populations.

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## Appendix

**Table A-1. After School STEM Reflection Questions**

<table>
<tr><td colspan="2">First Impressions (Completed on the beginning of the first day of class)<br>• What is STEM?<br>• Why are you taking this course?<br>• What do you hope to get out of this course?</td></tr>
<tr><td>Service Learning Reflections</td><td>Practicum Reflections</td></tr>
<tr><td>Pre-Reflection (Completed before beginning practicum)<br>• What assumptions and expectations do you have about the community in which you will be working?<br>• What assumptions and expectations do you have about the population (the kids) with whom you will be working?<br>• What do you imagine it will be like to teach about STEM to these students?<br><br>Mid-Semester Reflection<br>• To what extent does your experience so far agree with your initial assumptions about the community and the students?<br>• In what ways has your experience been different from your assumptions? What has surprised you? Why?<br>• What are the biggest lessons that you will take away from this experience so far?<br><br>End of Semester Reflection (Completed in class on the last day)<br>• What is STEM?<br>• How have your ideas about STEM changed by participating in service learning?<br>• Has this experience made you think differently about the community in which you taught this semester? Please explain.<br>• How might you apply knowledge and skills gained from this experience in the future to engage with your school community?</td><td>Mid-Semester Reflections (Completed twice, after teaching each Unit 1 and Unit 2)<br>• What has gone well and not well so far in your teaching of the STEM lessons?<br>• What would you change if you were to teach these lessons again?<br>• How will you apply what you’ve learned so far to your future lessons this semester?<br><br>End of Semester Reflection (Completed at the end of the semester)<br>• What were your biggest successes in your teaching of the STEM lessons this semester?<br>• What were your biggest challenges this semester in your teaching of the STEM lessons?<br>• What would you change if you were to go back to the beginning of the semester and teach these lessons again?<br>• What are your biggest take-aways from your experience teaching the STEM activities in the after school program?<br>• After this experience, do you (still) want to be a teacher?</td></tr>
</table>

The following presents a general description of the STEM activities in the course. An asterix (*) indicates an activity adapted from the *Engineering is Elementary* program (www.eie.org).

**Table A-2. Overview of After School STEM Activities**

### Intro to STEM Activities

***Tech in a Bag**

- **Goals:** This activity is meant to activate and challenge students' prior knowledge about technology and broaden students' definition of "technology."
- Students are asked to brainstorm everything related to the word "technology."
- Pairs of students are given a bag with an item inside (e.g. a paperclip, a plastic spoon, post-it notes, scotch tape, etc) and asked to discuss how their object is a technology.
- Instructor presents technology as "Anything human-made that solves a problem."
- Pairs of students answer: How is your item a technology? What problem does it solve? Students share their ideas and instructor leads a "technology" discussion

**Book: *Rosie Revere, Engineer* by Andrea Beaty**

- **Goals:** Introduce who an engineer is and what engineers do. Give children an image of an engineer who looks like them.
- Instructor shows the read-aloud of the book video from "Storytime from Space" (https://storytimefromspace.com/rosie-revere-engineer-2/).
- Students discuss: What do engineers do? Who is an engineer? What characteristics make a good engineer?
- The instructor uses the **Engineering Design Cycle** diagram from Engineering is Elementary (https://www.eie.org/overview/engineering-design-process) to discuss the process of engineering, including the concepts of **criteria** and **constraints**.
- For each Unit below, after introducing the problem, the instructor asks students: What are the criteria and constraints for this problem?

**Mystery Design Challenges**

- **Goals:** Students try out the engineering design process and practice collaborating with a partner. Get students to start to think creatively.
- Pairs of students are given a bag containing a variety of items and a "challenge card." Each challenge card describes a problem that needs to be solved through the creation of a new technology and each pair receives a different challenge. (Example: Someone left the door open and your house is full of flies! There are too many to swat. Design a technology to remove the flies from your house.)
- Students design and build a prototype to solve their problem. The instructor uses the engineering design cycle to guide the steps in the process.
- Students present their new technologies to the class.

### Unit #1: Flight & Rocketry

***Engineering Rockets**

- Students are told that they are stranded on the roof of their house and need to send a message to a neighbor using an air rocket launcher.
- Instructor introduces the three parts of a rocket: nose cone, fuselage, and fins.
- Instructor asks the class: What questions do you need answered to be able to solve this problem? Instructor answers the students' questions and asks students: What are the criteria and constraints for this problem?

- Students work in pairs to design and build a rocket. Each pair tests their rocket, and plots their data on a class data chart.
- The instructor leads a debrief discussion: Which rockets went the furthest? What do these rockets have in common? Differences? How might you modify your design to make it go further?
- Pairs modify their designs, retest, and plot their new data on a class data chart.
- The instructor leads a debrief discussion in which students describe what changes they made to their designs and why.

**Testing Ideal Launch Angle**

- Student pairs launch their rockets at different angles and record their data on a graph.
- Instructor leads a debrief discussion about the effect of launch angle on the distance the rockets traveled.

**Unit #2: Structural Engineering**

**Book: *Iggy Peck, Architect* by Andrea Beaty**

- Instructor leads a class discussion: What do architects do? What do architects have to do with engineers?

***Engineering a "Star Wars" Tower**

- Students are presented with a problem: You have been hired to design a structure to advertise the new Star Wars movie in Sacramento. The structure must be visually appealing and get people excited about the movie. You'll compete with other groups and present a prototype of your design to the city council. Your tower must hold Yoda and represent the spirit of the movie. (*Yoda is a stuffed toy*)
- Instructor discusses the addition of *A* to STEM (STEAM)
- Students work in pairs to design and build their towers
- Each pair presents their prototype to the class and tests its ability to hold Yoda.
- Instructor leads a debrief: What did you notice about all of the structures? What aesthetic components did groups incorporate? (How did you convey "Star Wars"?) What concepts about force and motion did you use to design and build the structure?
- Instructor introduces the concept of "force." Students brainstorm what forces are acting on their towers.
- Students revise their designs and retest.

***Engineering for Earthquakes**

- Discussion: What do you know about earthquakes? Have you ever experienced an earthquake? Why do structural engineers need to worry about earthquakes? How do you think earthquakes might influence the way structural engineers design structures?
- Students model the motion of different waves using strands of beads. Discussion: If a structure was sitting on the land above these waves, what would happen to the structure? What forces would be acting on the structure?
- Students are presented with a new problem: Design a structure that is at least 12 inches tall that can withstand a 5.0 earthquake. The structure must have 2 stories with a floor, ceiling, and roof.
- Students design and build their towers. Each pair tests their tower on a shake table.
- Debrief discussion: What did you notice about characteristics of structures that worked? (and didn't work?). What improvements did you make during this process? What concepts did you

use to design and build the structure? How did you apply what you learned from the Star Wars Tower building activity?

**Unit #3: Force & Motion**

**Lifesaver Cars**

- Challenge: Create a car that will travel the greatest distance, in one round (as defined by one start and stop). You cannot push the car.
- Students work in pairs to design, build, and test a car. As students test, they record their data on a data table including: distance, notes about design, and revisions. Students are encouraged to revise as they test and to record any revisions they make.
- Debrief: Each group shares their design.
- Discussion: How can you connect the concepts about force and motion? Instructor introduces the definitions of force, motion, balanced forces, unbalanced forces, and Newton's first law of motion. Students work in pairs to answer the question: Describe why some cars went further than others using the terms force and motion.

**Catapults**

- Challenge: Create a device that can hurl a pompom into a cup placed at specific distances away from the device (1 foot, 2 feet, 5 feet, and 10 feet).
- Student pairs plan, build, and test their catapults. Students record their data as they test (distance and notes about their design)
- Debrief: Describe your group's design. Was it successful (did it meet the criteria)? How did you adjust to hit the target at each distance? Describe why your design was successful (or not) using the terms force and motion.

**Rollercoasters (Marble run)**

- Discussion: What do you know about rollercoasters? Look at the pictures of rollercoasters: What do these rollercoasters have in common? What makes a rollercoaster fun? How can you use science words in your descriptions?
- Instructor introduces new words/concepts: speed and velocity. What do speed and velocity have to do with force and motion?
- Students work with a partner to answer: Describe what makes a rollercoaster fun using the words speed, velocity, force and motion.
- Challenge: Design a "fun" rollercoaster using your knowledge of force and motion.
    - Step 1: Explore the materials to change speed and velocity. Changing **speed**: How slow can you make the marble go? How fast? Can you make the marble go fast, then slow without changing its direction? Changing the **velocity**: How many turns can you get the marble to go through without falling off the track? Can you make the marble go up and down a hill? Can you get the marble to go in a loop?
    - Step 2: Use the knowledge that you've just gained to design and build a rollercoaster.
- Debrief: Each group presents their rollercoaster to the class. How many changes in speed does it have? How many changes in velocity?