Using the maker movement to forge a middle-school collaboration to support English language learners

BY RACHEL FIORE AND MARJORIE COOPER

We—a middle school teacher at the Global Village Project, a middle school for recently arrived refugee girls, and a college assistant professor at Georgia State University—have established a collaboration to use the maker movement to bring science, technology, and engineering experiences to middle school students who are English language learners (ELLs), as well as elementary education undergraduates who have a concentration in English as a second language (ESOL). This collaboration allows our students to learn about each other and themselves in an environment where both sets of students are equal partners. Our students also learn about the maker movement, which can be leveraged to provide middle schoolers with access to science, technology, and engineering outside of school. As part of the collaboration, both sets of students have an opportunity to share activities with kindergarten and first-grade children. The emphasis on kindergarten and first-grade activities helps both sets of students. The college students gain experience planning and doing science with early elementary students, whereas students from the Global Village Project (see Resources), many of whom come from cultures where older siblings take care of younger siblings, have the opportunity to use academic English with younger students. This increases their comfort level with the language and creates a school-culture connection.

The authors send pictures of their maker faires to administrators to gain support.

We chose to base our collaboration on the maker movement as a way for any student to access the science and engineering practices and crosscutting concepts of the *NGSS* outside of the opportunities provided for them at their schools. The importance of additional attention to underrepresented groups is detailed in Appendix D of the *NGSS*, "All Standards, All Students: Making the *Next Generation Science Standards* Accessible to All Students" (see Resources). Within this document, seven groups of

students are identified, all of which our partnership should be able to support. Because our middle school is for teenage girl refugees, our collaboration matches the recommendations in Appendix D for students with limited English proficiency (*opportunities for discourse and home/community connections*) and girls (*exposure to female scientists and engineers as well as extracurricular STEM opportunities*). The collaboration also supports teacher preparation because our preservice teachers experience effective strategies for including "all students regardless of racial, ethnic, cultural, linguistic, socioeconomic, and gender backgrounds." This collaboration also serves as a model for our preservice teachers to "identify ways to make connections between school science and home/community for non-dominant student groups as they engage in the NGSS."

Background on the maker movement

The *maker movement* is an international movement generally described as starting in 2005, with the publication of *Make Magazine* and use of the word "maker" (see Resources). Two ways to learn about the maker movement are by reading a book called *The Maker Manifesto* and by exploring the Maker Media website (see Resources). The maker movement can be explored in a hands-on manner through makerspaces and maker faires. *Makerspaces* are permanent places where makers use communal equipment and work on projects. Makerspaces have a common theme of valuing "making" and bringing together people who want to make things. Making can take many different forms. For example, many people think of maker projects as building robots and drones. However, weaving, sewing, and woodworking are also three key components of the maker movement. Makerspaces usually have membership fees but also often provide scholarships. Makerspaces vary in their complexity; some are bare-bones, whereas others are located in huge warehouses and offer classes. Many makerspaces are found in buildings that are not schools, but schools and colleges (including ours) are adding makerspaces for students and community members. To find a makerspace near you, use the Makerspace website (see Resources).

Maker faires are family-friendly public events that highlight the maker movement. Maker faires occur across the United States and around the world. Maker faire sponsors often include colleges, K–12 schools, businesses, and makerspace members. A maker faire is usually a one-day event or held over a weekend. Like other festivals, a maker faire is filled with booths, but it often also has a bigger space where people demonstrate homemade cars, retrofitted bicycles, custom-programmed drones, and other innovations. To find a maker faire near you, use the official Maker Faire website (see Resources).

We have experienced the maker movement as a loose association of people with the common goals of making and sharing

CONTENT AREA

Physical science, engineering

GRADE LEVEL

6–8

BIG IDEA/UNIT

University/K–12 school collaborations

ESSENTIAL PRE-EXISTING KNOWLEDGE

None required

TIME REQUIRED

Four 45-minute class periods, visiting each other's schools and the maker faire

COST

Approximately $125 (varies, depending on the selected activities); transportation (varies, depending on individual school situation)

SAFETY

Safety awareness for a large public event (four chaperones for 15 students)

ideas, with each makerspace and maker faire being unique to that community's needs. For us, the maker movement is STEM's free-spirited cousin. Although there is overlap between the maker movement and education, they are not identical. A good overview of the differences and similarities between the maker movement and STEM education can be found in the review article "The Maker Movement in Education" (Halverson and Sheridan 2014).

Developing a collaboration

Step 1: Find a collaborator

You can initiate a collaboration like ours whether you are a middle school teacher or a college professor. The key is making the connection between two people who have a common interest in the maker movement or STEM. One way is to start a conversation about the maker movement. In our case, having previously worked together in a local public school system, we naturally fell into a conversation at a chance meeting and discovered we share a common interest in providing real-world opportunities in science to our students. Another approach is to look online at the research interests of professors at nearby universities and contact those with relevant interests (e.g., STEM education, the maker movement, ESOL instruction). You can also make connections at the makerspace in your community. Makerspace members often include teachers and college professors who may be eager to share their knowledge and experience with interested students, especially because sharing is such a huge emphasis in the maker movement. It is important that the two collaborators discuss and establish the benefits of collaborating for both sets of students. Our focus is on having ELLs fully engaged in STEM and making and displaying their full range of talents and capabilities independent of English fluency to preservice elementary teachers. Thus, we intentionally craft interactions where the two sets of students learned alongside each other.

One additional factor to consider when finding a collaborator is how students are going to get to each other's schools and the maker faire. This is an important factor in both time and cost. In our case, the schools are 20 minutes apart, and we have used both public transportation and school vans to transport the middle school students to the university and the maker faire. The college students have used public transportation or their cars. We have both sets of students visit each other's school to establish the equality of the collaboration.

Step 2: Register for a nearby maker faire

Finding the dates for the local maker faire helps you work backward to plan your collaboration. If your next faire is at least three months away, you have enough time to prepare. If the faire has already been held, you can plan for next year. Registration for a booth at a maker faire is commonly free for K–12 schools, colleges, and nonprofit institutions. If there is a cost, check whether the university is a sponsor of the maker faire; if so, this would allow you to share booth space.

Step 3: Introductions

During the first year of our collaboration, we used Google Hangouts for the students to meet before the college students visited the middle school. It was wonderful to see both sides asking questions and learning things about each other, especially sharing how many languages were spoken, among both sets of students. The downside to this was that there were a lot of students on both sides crowding around the screen, and not everyone spoke. The second year, we used the free version of an app called Flipgrid (see Resources). In Flipgrid, students separately record video introductions with their names and a fun fact about themselves. We like this way of doing the introductions because it highlights the diversity of both sets of students, and every student speaks. For both sides, it is a fun, fast, novel, and simple way to do introductions. It also has the benefit of producing recordings of all of our students saying their names, which helps us, as teachers, have a place to check that we are correctly saying our students' names.

Step 4: Practice hands-on activities for the maker faire at the middle school

After the first year of the collabo-

ration, we decided we needed an additional opportunity for the middle school and college students to get comfortable working together, because they tended to separate into their own groups at the maker faire when we wanted them working together. Therefore, in the second year, we added a visit by the college students to the middle school. The purpose of the visit was to try out different activities that we might want to bring to the maker faire. Each college student brought a hands-on STEM activity for a kindergartener or first grader that they had prepared for a class assignment (but had not yet tried). The middle school teacher provided K–1 STEM activities for the middle school students to share with the college students, because having the middle schoolers find activities was not the goal of our collaboration. Our focus was on students getting experience explaining to and helping children at the Faire.

During the visit to the middle school, both groups of students set up their hands-on activities, and everyone rotated through the stations in pairs of one college student and one middle school student. There was random pairing of the two students. The directions were on the activity and written at a K–1 level. All students visited all stations. No student stayed at the station to explain. The written instructions, pictures, and models guided the pairs of students through the activities. The students spent about 90 minutes participating in approximately 15 centers. After practicing the STEM activities with each other, students chose which activities to bring to the maker faire. We did not limit the number of activities that students could choose, but we also did not promote bringing all of the activities, because students could see themselves that some activities did not work well, were too complicated, or were not engaging. Students voted on which projects to take. We took between four and eight projects to the maker faire. The projects students chose had to be cheap, able to be completed quickly (e.g., no glue or paint to dry), have a variety of iterations, and not require water (no boats). Some projects were the same from year to year, as we did not limit what students could pick. At the last faire, the titles of the activities that we presented were: Balloon Rockets, Color Monsters, Rubber Band Guitars, Cereal Mazes, Marble Runs, Kazoos, and Paper Helicopters (Figure 1).

Step 5: Present hands-on STEM activities together at the maker faire

Before students present at the maker faire, we determine how the middle school students are going to get there, how long we expect each set of three to four college students to stay, what materials we need, and how we are going to pay for the materials. In our case, the middle school students come with the teacher on a bus and stay for four to five hours. The college students work in three-hour shifts (two hours at the booth and one hour exploring the faire). We build in time for students to visit the booths at the maker faire to see the range of activities, especially the technology exhibited by college and high school clubs. One change we will make next year is adding chaperones from the middle school, so the students can work in shifts like the college students,

FIGURE 1: Sample successful maker faire projects

- Harmonica *http://bit.ly/30V32KN*
- Color spinner *http://bit.ly/2KmOcZr*
- Kaleidoscope *http://bit.ly/2HLLadu*
- Maracas *http://bit.ly/2EOxg8O*
- Kazoos *http://bit.ly/2YW39DZ*
- Catapult *http://bit.ly/2KhFqda*
- Flying machine *http://bit.ly/2HMg6KO*
- Buzzy bee *http://bit.ly/2JODUjx*
- Marshmallow launcher *http://bit.ly/2XdSgNq*

providing one chaperone for four students.

We keep our presentation at the faire simple. We cover the folding tables (72 inch by 30 inch) provided with a school tablecloth, put out sample completed projects along with the materials, and wait for children who are attending the maker faire to approach. Each of us provides materials, but students lead all of the activities. We have both been lucky to get support from our administrators, and the total cost of the materials has been about $125 for each year.

Some of our students are more comfortable than others when it comes to reaching out to the children passing by the booth, but once the children start working on the projects, all of our students uniformly become engaged. We emphasize beforehand that the number of participants is out of our control. The first year our booth was in a great position and the table was packed. The second year, the weather was not as good, it was a new venue, and we were off to the side, all of which led to fewer participants.

Step 6: Visit the college and learn about makerspaces

One of our priorities is to bring the middle school students to the college campus so that they can see college students who look like them preparing for careers, hoping that they will envision college as a part of their future. We use the college visit to have both sets of students experience some of the engineering aspects of the maker movement. The first year we used a makerspace on the college campus, and both sets of students did 3-D printing with Tinkercad using Scratch and PicoBoards (see Resources). The second year we were short on time and did not go into the makerspace itself, but we still used Scratch and PicoBoards. We have the middle school and college students randomly pair up because our goals are to build awareness and confidence in both sets of students. In this situation, neither set of students has worked previously with Scratch or PicoBoards, and both of us saw authentic collaboration between students during the activity, including many instances where the middle school students were leading the college students in the exploration.

During the college visit, we also include a walk around the campus, which allows the middle school students to see a variety of student ethnicities and visualize how they would fit in on a college campus.

Step 7: Send pictures to supporters and plan for next year!

During our visits to each school and the maker faire, we take pictures and send them to our administrators within days of the event. We do this not only because we are proud of our students, but also to sustain collaboration support from administrators. The middle school requires permission from parents for photos, so only students with that permission are photographed. Establishing school-university partnerships helps both institutions. For example, when we shared our collaboration with our respective administrators, this prompted them to talk and complete a formal memorandum of understanding between the school and university that we did not even know was in progress.

Student reflections

Back at our own schools, we ask our students to reflect on the experience using the questions "What did you get out of the collaboration with the students from The Global Village Project?" and "What did the students from The Global Village Project get out of the collaboration with you?" The college students do this through written reflections. The middle school students orally answer the same questions. Figure 2 illustrates the impact on the middle school students. Figure 3 illustrates the impact on the college students.

Final thoughts

We started our collaboration because we each had needs related to English language learning. The middle school teacher wanted to provide students experiences with college that went beyond a tour, as well as opportunities for her students to talk about science outside of the classroom. The college professor wanted her science methods students to meet ELLs in an environment where middle schoolers were able to demonstrate their creativity and curiosity in a way

FIGURE 2: What do the middle school students get out of the collaboration?

Middle school students	College students
"Getting to know what college looks like and what you have to do."	"They were able to practice their English in a nonjudgmental environment. … They also were exposed to a college campus which to me is a form of motivation to work hard so one day they can attend a university."
"They were so nice and kind to us. They were friendly."	"They learned that soon-to-be teachers understand [students] and how we strive to incorporate differentiation in order to help all students succeed."
"They taught us and we taught them. We taught each other."	"I think that the experience to work alongside college students allowed some of the girls to think critically about going either into the sciences or education field one day. Overall the collaboration was a great experience in which both parties benefited!"

Written college student work used with permission (in order by quote) from Lauren T., Michelle P., and Demi W. Middle school oral comments cited anonymously.

FIGURE 3: What did the college students get out of the collaboration?

Middle school students	College students
"They learned that we like science."	"I got that language should not be an obstacle to teaching science. Everyone/every student should have an equal opportunity to learn science." "We have been reminded that these students may need some modifications to convey language but not learning. These students learn the same as other students. … I hope to keep this project in mind when faced with teachers who think that the ESOL students cannot or should not need to learn science."
"We are nice, that we are good students. We work hard, listen, and speak many languages. We are smart."	"… how smart [the students] were … the day they came to us I learned from my partner because she was able to understand the website better than I did …"
"They learned that we are funny and we like to talk."	"… giving students an opportunity to share what they know … being sure to keep that door open helps provide confidence for each student."
"They learned that we are just like them. Some of them were immigrants from other countries, like us. Some were African, some were Asian, some were from Europe. Some were from Mexico."	"I got [a] firsthand example of how small the world is. Although these girls had been displaced and moved from their home country, they were still typical teenagers, still shy and jokeful and interested in trying new things."

Written college student work used with permission (in order by quote) from Wendy W., Katelyn S., Kim B., Gerardo R. and Olympia S. Middle school oral comments cited anonymously.

that was not language-focused. We chose the maker movement because it serves as a resource for increasing access to STEM and supporting ELLs' interest in science and technology outside of the classroom. The activity could be done with any group of middle school students and preservice teachers if there is an authentic reason where both sets of students learn from each other.

Through the maker movement, we help both middle schoolers and aspiring teachers in an exciting and visible education collaboration. ●

REFERENCES

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NGSS Lead States. 2013. *Next Generation Science Standards: For states, by states*. Washington, DC: National Academies Press. *www.nextgenscience.org/next-generation-science-standards*.

RESOURCES

About the Maker Movement—*https://makermedia.com/maker-movement*

"All Standards, All Students: Making the *Next Generation Science Standards* Accessible to All Students"—*www.nextgenscience.org/sites/default/files/Appendix%20D%20Diversity%20and%20Equity%206-14-13.pdf*

Find a Faire—*https://makerfaire.com/map*

Flipgrid app—*https://info.flipgrid.com*

Hatch, M. 2014. *The Maker Movement manifesto*. New York: McGraw Hill.

The Global Village Project—*www.globalvillageproject.org*

Maker Faire—*https://makerfaire.com*

Maker Media—*https://makermedia.com*

Makerspace—*https://spaces.makerspace.com*

PicoBoards—*www.sparkfun.com/products/13863*

Scratch—*https://scratch.mit.edu*

Tinkercad for 3-D printers—*www.tinkercad.com*

Rachel Fiore [*rfiore1@gsu.edu*] is an assistant professor in the Department of Early Childhood and Elementary Education at Georgia State University in Atlanta, Georgia. **Marjorie Cooper** is a science and STEAM teacher at The Global Village Project in Atlanta, Georgia.

Georgia State University and Global Village Project students enjoying their time teaching together