

COLLABORATION BY DESIGN:

encouraging

**positive
interactions**

through

engaging tasks

by Pamela Chapman and Thomas Roberts



Figure 1.

What has your experience been like with collaborative learning in the elementary STEM classroom? Just like a roller coaster, student collaboration in the classroom can take students to new heights in their learning, but it can also lead to several lows. In typical visits to many schools, you may see students working in groups with math manipulatives to solve problems or sitting in pairs at a computer as they learn to program in robotics class. Both situations require collaboration. How the students interact, however, depends on how the collaboration and task are structured. Are some students fading into the background while one student takes the lead in solving the math problem? Are all of the students actively contributing to programming the robots? Great collaborative learning tasks engage and excite students, require students to apply their knowledge, and demand the valuable participation of every group member.

As teachers, we strive for good collaborative learning activities in our classrooms. We also regularly encounter group activities where one student takes over or where collaboration breaks down. In these cases, the students are not gaining the learning and innovation skills termed the 4Cs—critical thinking, communication, collaboration, and creativity—by the Partnership for 21st Century Learning. Students today need to be able to collaborate with each other by working with diverse groups, being both

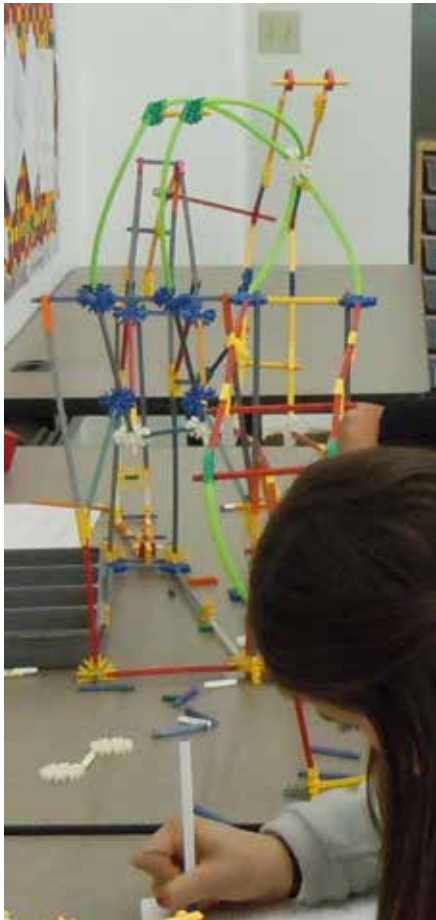


Figure 2.

flexible and willing in designing solutions for a shared problem, sharing responsibility for the group's final outcome, and valuing each group member's contributions to the group (Trilling & Fadel, 2009). Establishing norms of collaboration and providing students with specific roles in collaborative learning helps increase the learning of all students in the group.

Complex Instruction (CI) is a form of cooperative learning in which the teacher strategically assigns roles to ensure individual participation as the group works on tasks that are "uncertain and open-ended both in their solution and in the process" (Cohen, Lotan, Scarloss, & Arellano, 1999). A key component of CI is assigning students meaningful roles within the group. Using jobs helps to create opportunities and norms for collaboration within the groups. The following jobs work well for groups of five: principal investigator, supply manager, data manager, time manager,

and strategic questioner. The principal investigator takes on the role of a facilitator, ensuring that each member fulfills his or her role. The supply manager is responsible not only for gathering materials, but also for ensuring the tools are used and chosen appropriately. The data manager records the group's data as it is collected and ensures it is displayed appropriately (i.e., choosing a bar graph or T-chart). The time manager not only helps keep the group informed of the amount of time remaining on the project, but also helps move the group along in its process to meet the deadline. Finally, the strategic questioner ensures that all possibilities have been explored by posing questions such as "What's another idea?" or "Does this design solve the problem most efficiently?"

These roles give each individual a meaningful way to contribute to the group. Moreover, they also allow the group to practice the Standards for Mathematical Practice and the practices of science

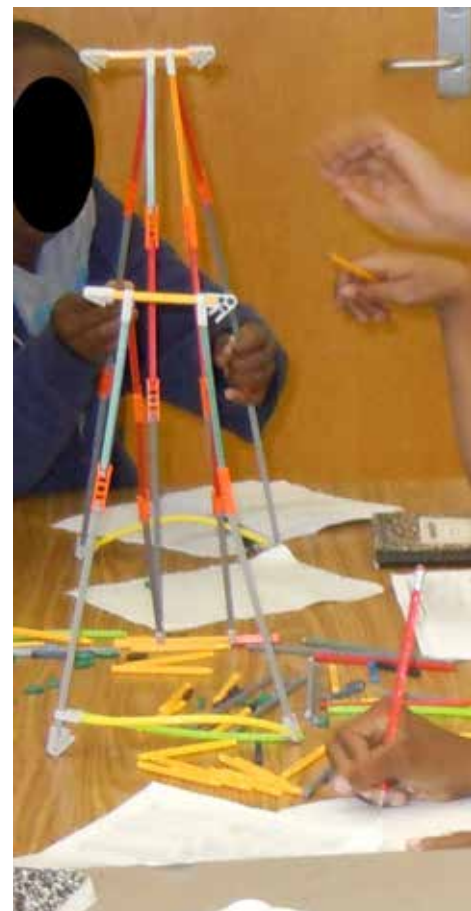


Figure 3.



Figure 4.

or engineering. For example, the strategic questioner's role is key in asking questions and defining problems—the first practice of science and engineering (*Next Generation Science Standards*, 2013). The data manager collects data to help construct viable arguments (*Common Core State Standards*) and to analyze and interpret data (*Next Generation Science Standards*, 2013). Thus, the roles are designed not only to maximize students' engagement with content and with each other, but also with the processes important to the disciplines.

How would your students respond to using these jobs in a collaborative learning activity? Designing and building roller coasters provides a real-world context for students. What content comes to mind from looking at Figure 1? There can be rich discussions about geometric shapes in math. In science, students can discuss forces, speed, and energy transfer, among other topics. How the roller coaster was designed is a great engineering discussion starter.

suggested grade level: 4th-6th grades

As students are learning about forces and decimals, this roller-coaster activity combines both, along with engineering, to have

students apply their content knowledge, engage with important content practices like the SMPs and science practices, and collaborate with each other to create meaningful solutions.

Step 1: Give students an open-ended prompt that builds interest, establishes criteria, and provides relevant constraints. For example, "An amusement park is considering opening in (your town). They have asked local students to work together to design one of the rides. You need to design and build a model of your proposed ride. You will have a budget of \$100 for the building supplies, so choose your materials and create your design with this in mind."

Step 2: Assign students their jobs for the group work and review the group norms of collaboration to remind students of expectations (i.e., rotating leadership, emphasizing appropriate noise levels, and limiting sidebar conversations).

Step 3: Have students draw a design of their roller coaster. We usually require students to include a materials list with their design. Each material "costs" a certain amount of money. For example, maybe a large cardboard tube costs \$1.25 while a piece of copy paper costs \$0.15. You can be creative with the price list based on the materials you have available and your students' abilities to perform operations with decimals.

Step 4: Build the roller coaster based on the design. If time permits, improve it!

Step 5: Have each team present its work, explaining the design, the strategy in staying on budget, the effects of balanced and unbalanced forces, and the process. Be sure to encourage students to use the appropriate key vocabulary in their presentation.

Step 6: Have the class collaboratively give feedback on the things they like about the design and on ways it could be improved. Students can give warm (positive) and cool (adjusting) feedback to the group.

Emphasize the importance of collaboration as students work on their projects. Meaningful collaboration aids in improving the classroom culture, increasing active learning, developing accountable talk, and empowering students to take ownership in their learning. Most importantly, collaboration boosts the self-worth of those students who typically fade into the background during class

feature activity

discussion. Figures 2-4 show some examples of student-made roller coasters.

references

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