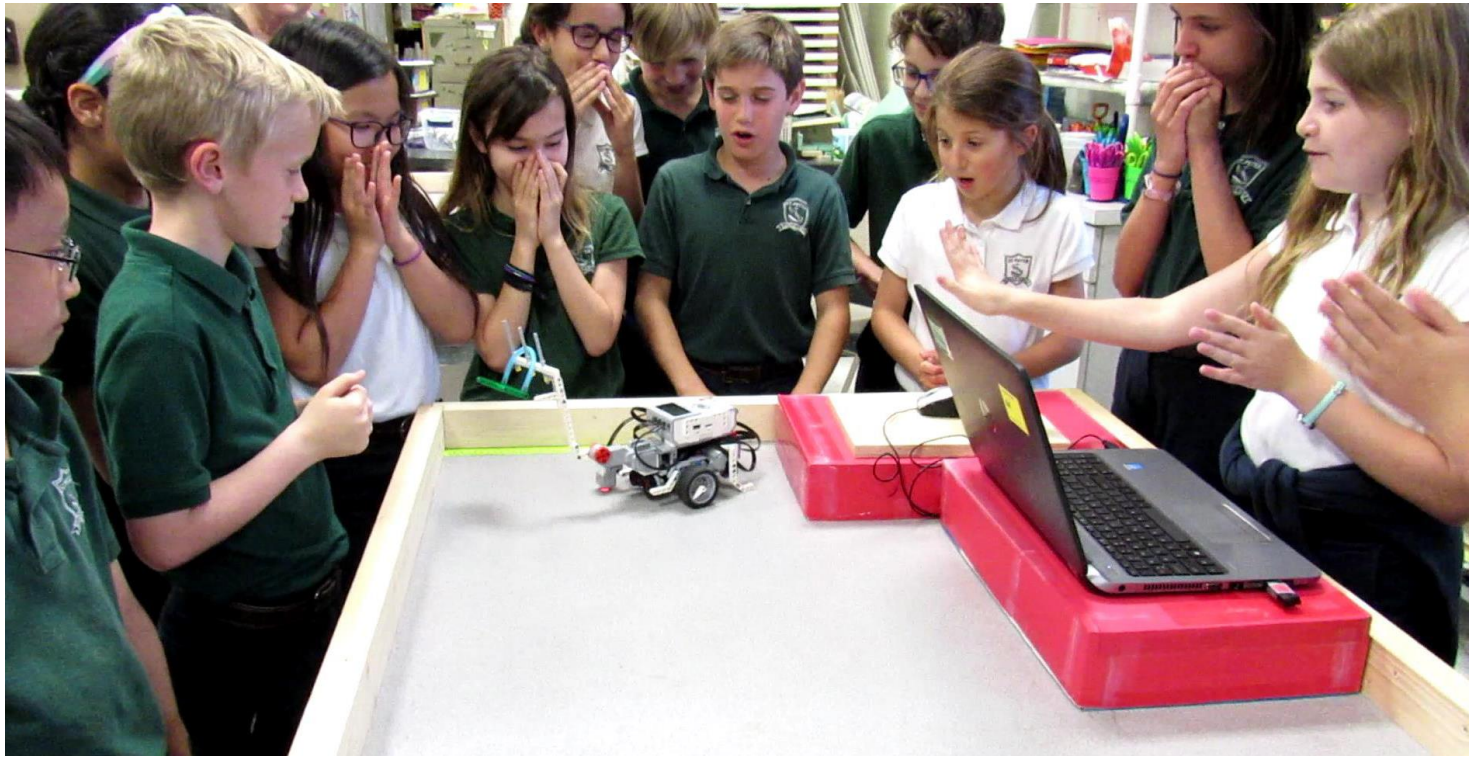
Introduction of Robotics into Art Classes at Saint Peter Catholic School during Spring 2018

By John Bell III, MFA
K-8th Grade Art Teacher and FIRST Lego League Robotics Coach

Students at Saint Peter Catholic School of Greenville, NC began building and programming autonomous robots as part of their work in 3rd-8th grade art classes during the spring of 2018.

Through this work, students were exposed to the art-related career field of engineering, and experienced how math affected real, physical outcomes as they programmed their robots.

To design and construct robots, students applied the type of spatial intelligence and structural reasoning that is also used in the art of sculpture.



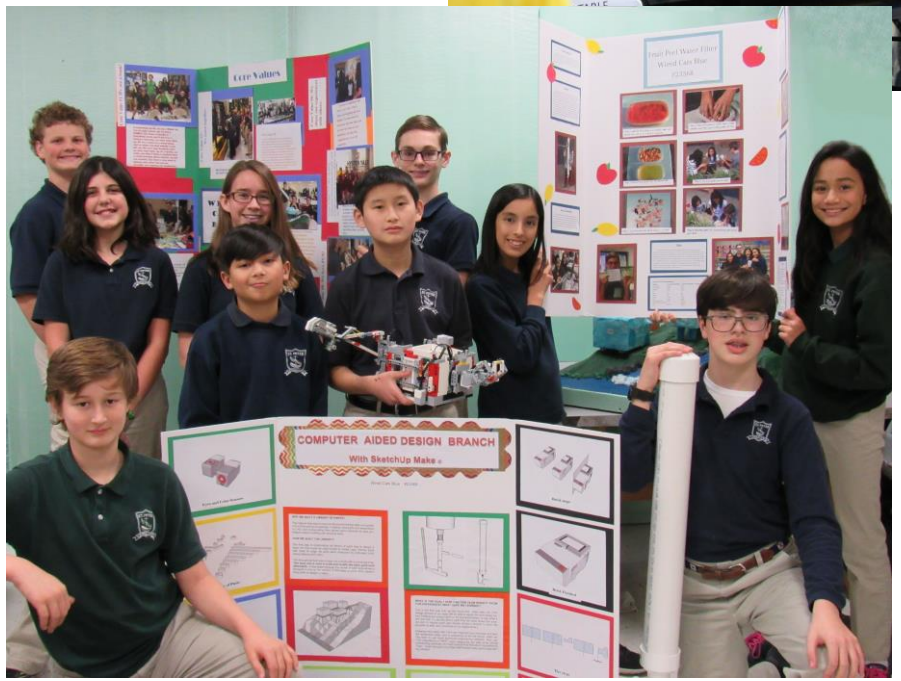
4th graders focus watch as a team's robot performs well on a mission.
Groups of 3 or 4 students in each 3rd - 8th grade class programmed their robots to complete challenges.

Positive Effect of FIRST Lego League Teams

The success of Saint Peter's FIRST Lego League robotics teams was a major factor in bringing this STEM activity into the art curriculum. (Both of the school's FLL robotics teams qualified for the NC FIRST Lego League State Championship tournament during the 2016-17 and 2017-18 seasons.)

After their 2017-18 season ended, FLL team members worked after school to help get the program started and shared their knowledge with peers during robotics sessions in art classes.

Several generous parents and the administration showed their support for robotics at Saint Peter by providing funds for materials.



Greenville, NC
The Daily Reflector
newspaper article
(as it appears on reflector.com)

St. Peter competes in robotics state championship

Tuesday, February 13, 2018

St. Peter Catholic School had two teams to participate in the NC FIRST Lego League Championship tournament in Greensboro last month.

Of the nearly 60 teams competing, the WiredCats Blue had the 11th highest score in the autonomous robot game competition, and the WiredCats Green had the 16th highest score.

The WiredCats teams qualified for the state championship because of their performance at last fall's FIRST Lego League Regional Qualifying Tournament, where they were among six teams selected from the 20 that participated. At the regional competition, Wiredcats Green won the engineering project presentation trophy for its robotic composting toilet. Wiredcats Blue won the robotic programming trophy.

Wiredcats Blue team members are Andrea Castillo, Jamie Galinis, Lauren Hodgson, Brighton Hou, Carter Lamson, Tiago Marlow, Stuart O'Connor, Jasmine Pandya, Jeremiah Reid and Gerald Reiling.

Wiredcats Green team members are Skyler Barnaby, Lincoln Bond, Alex Cooper, Frankie Kennedy, Jason Napast, Elliana Proctor, Jackson Schreiber, Alexander Turner and Rylan Tuten.

The teams are coached by John Bell and Kevin Pandya. Former St. Peter students Allanah Napast, Ryan Moloney and Nate Hasselbach, who are now in high school, served as mentors this season.

St. Peter Catholic School's WiredCats team members recently participated in the robotics state tournament in Greensboro.

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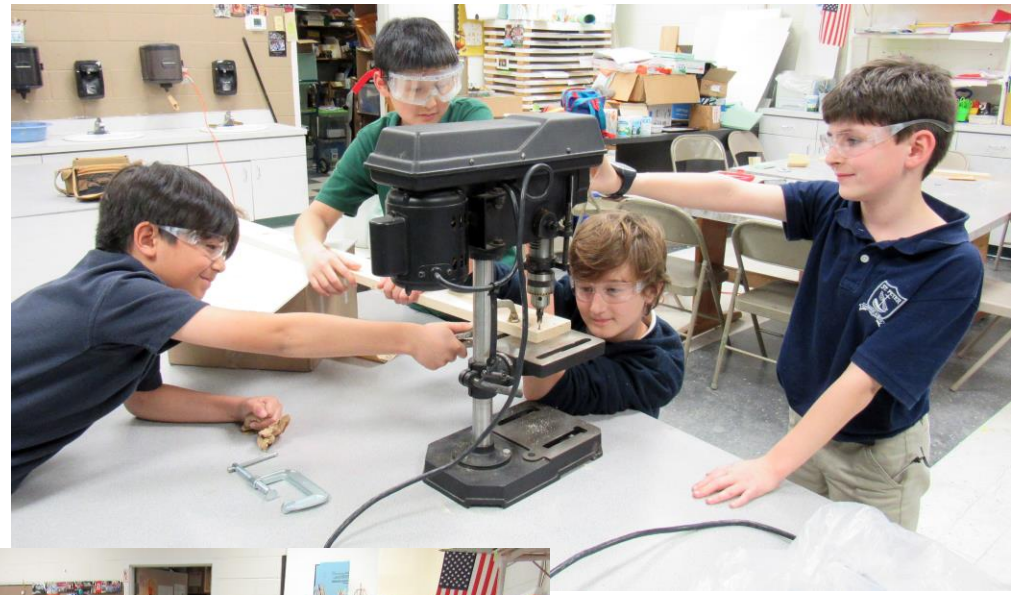
Development of Support Structures and Setup

In February 2018 Saint Peter middle school robotics team members constructed six large wooden table top frames that allow the art room tables to quickly convert for use with robots in the art classes.

The frames were based on a teacher-generated prototype. Each of the seven frames (six made by students and one made by the art teacher) provides a 2 ½ inch wall along the edge of the tables which keeps robots and parts from falling off, and which can also be detected by the robots' sensors.

Robotics team members also reinforced and covered fourteen 3 x 12 x 18 inch cardboard box lids with colored paper to serve as supports for one computer and one mouse pad per table. The pair of box lids at each table has a distinct color that is used to identify the table.

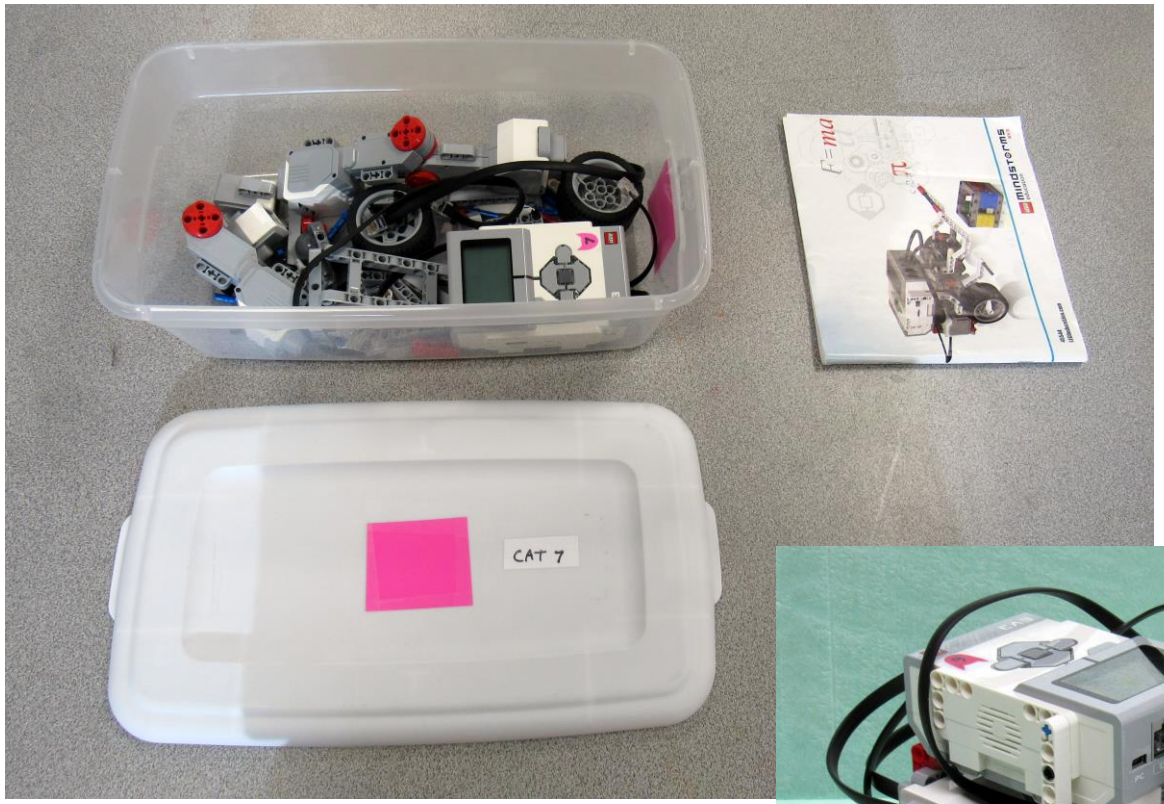


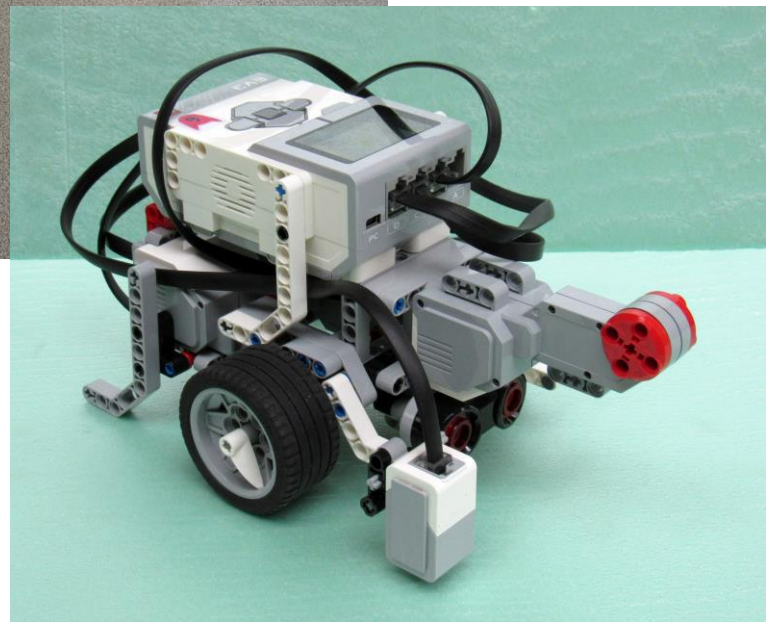
Robot Parts Kits

Saint Peter middle school robotics team members assembled eight basic Lego EV3 robots according to an instruction manual. The addition of a front-end motor was not included in the instructions but was added to allow for a front-end lifter arm.

Students tested all the parts, disassembled the robots, and then packed the parts into color-coded boxes for use in the art classes.

Each box included an EV3 Intelligent Brick, 3 Large Servo motors, an ultrasonic sensor, a color sensor, cords for connecting sensors and motors to the brick, and several Lego Technic construction pieces.





Equipment Transitions

Art student volunteers helped set up and remove robotics-related structures and equipment when it was necessary to change the arrangement of the art room tables.

This process took about twenty minutes and was usually done at the beginning or end of a school day.

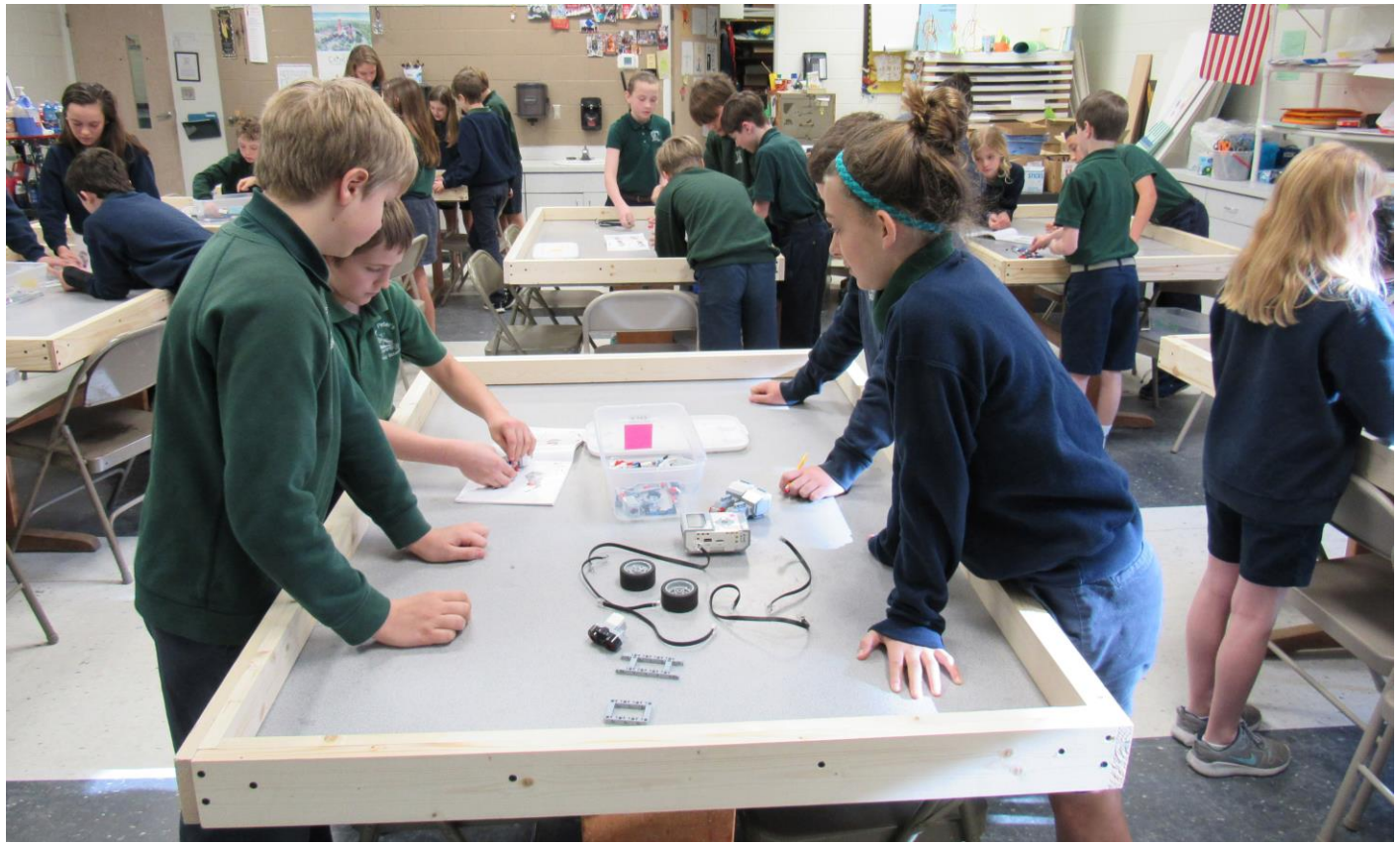
Introduction of robot design/construction and programming basics

In March 2018, fifth graders became the pilot group for the use of EV3 robots in Saint Peter art classes.

They worked in small groups to build and program EV3 Lego robots to accomplish a series of challenges.

Using the parts kits prepared by the Saint Peter FLL teams, seven groups of four students in both fifth grade art classes took turns building the base robot form from an instruction manual.

Afterwards, each group designed their own robot arms for picking up objects.



Greenville, NC
<u>The Daily Reflector</u>
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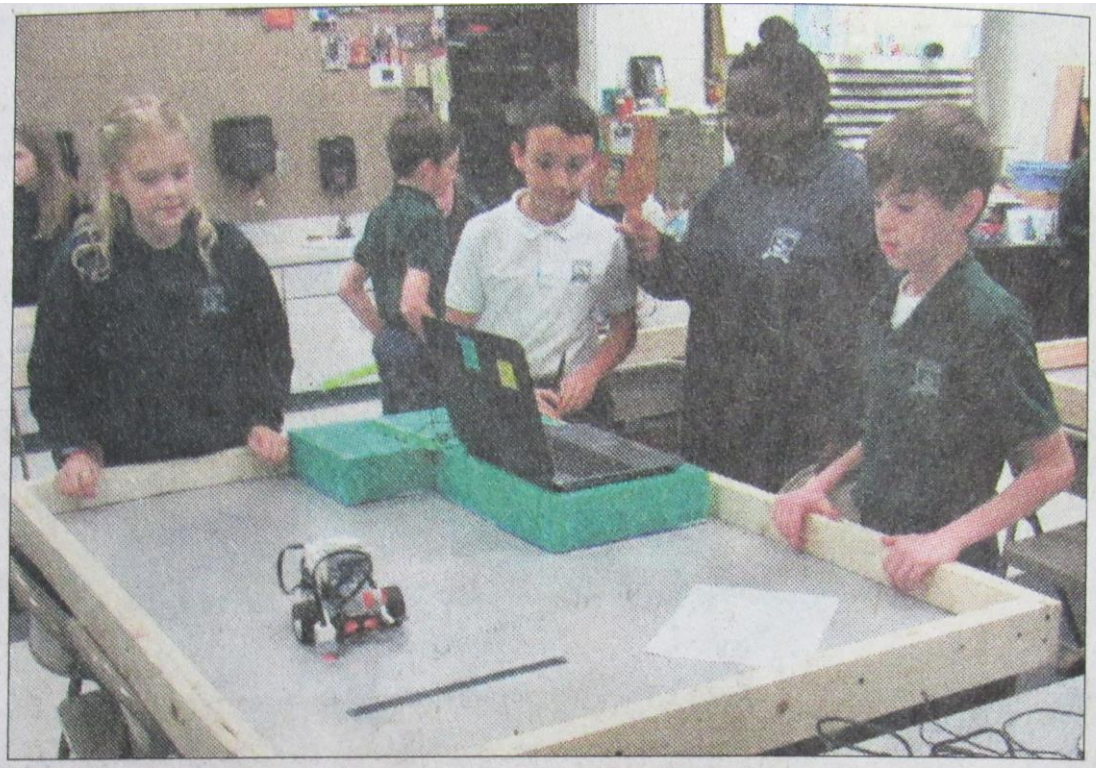


St. Peter Catholic School students have been building and programming autonomous robots as part of their work in art classes. Earlier this spring, fifth graders began working in small groups to build and program EV3 Lego robots to accomplish a series of challenges. John Bell is the art teacher and head coach of the Wiredcats FIRST Lego League robotics teams. Above are students Caroline Cole, Ryan Scargle, Anne Escambe and Jack D'Alonzo.

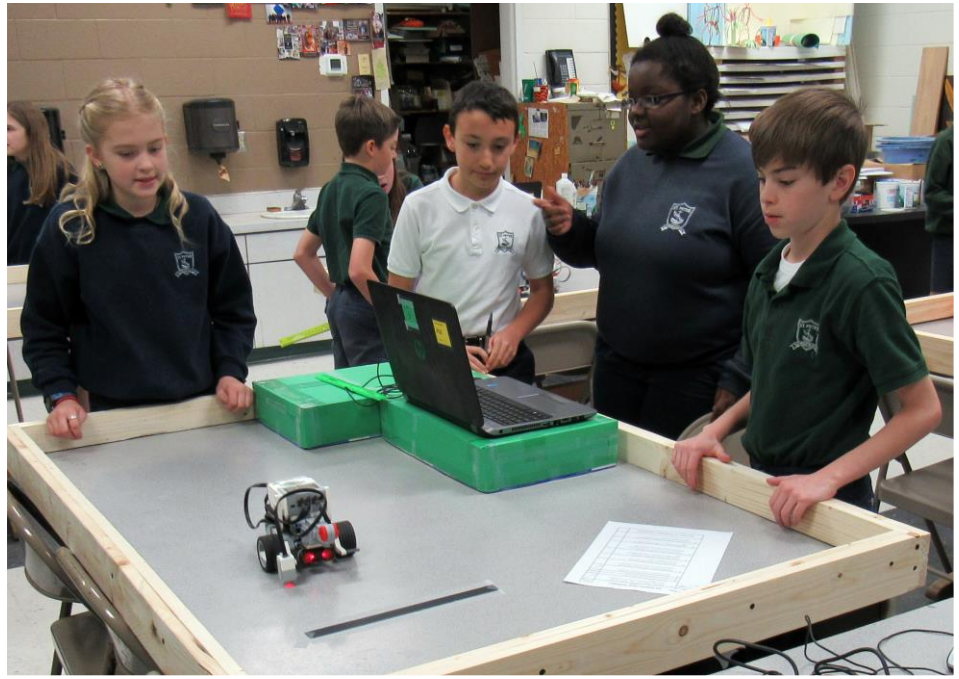
Sensors, Software, and Math

Students learned to use a color sensor for detecting and following a black line and an ultrasonic sensor to detect the wall.

They programmed their autonomous robots using Lego Mindstorms Education software, which is a free download.

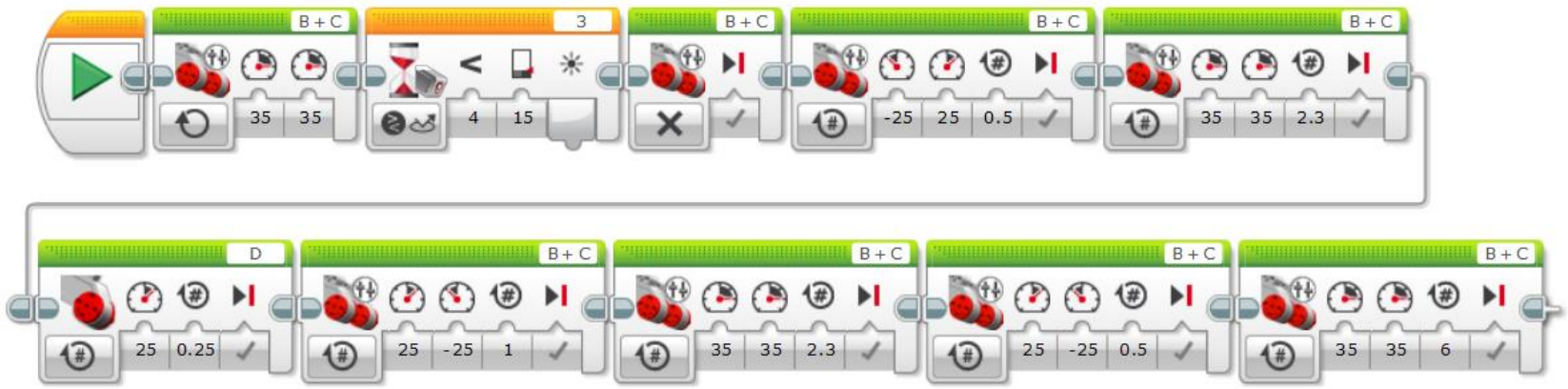
Lego Mindstorms Education programs were transferred from each group's notebook computer to an EV3 robot by either Bluetooth or by a removeable cable connection.

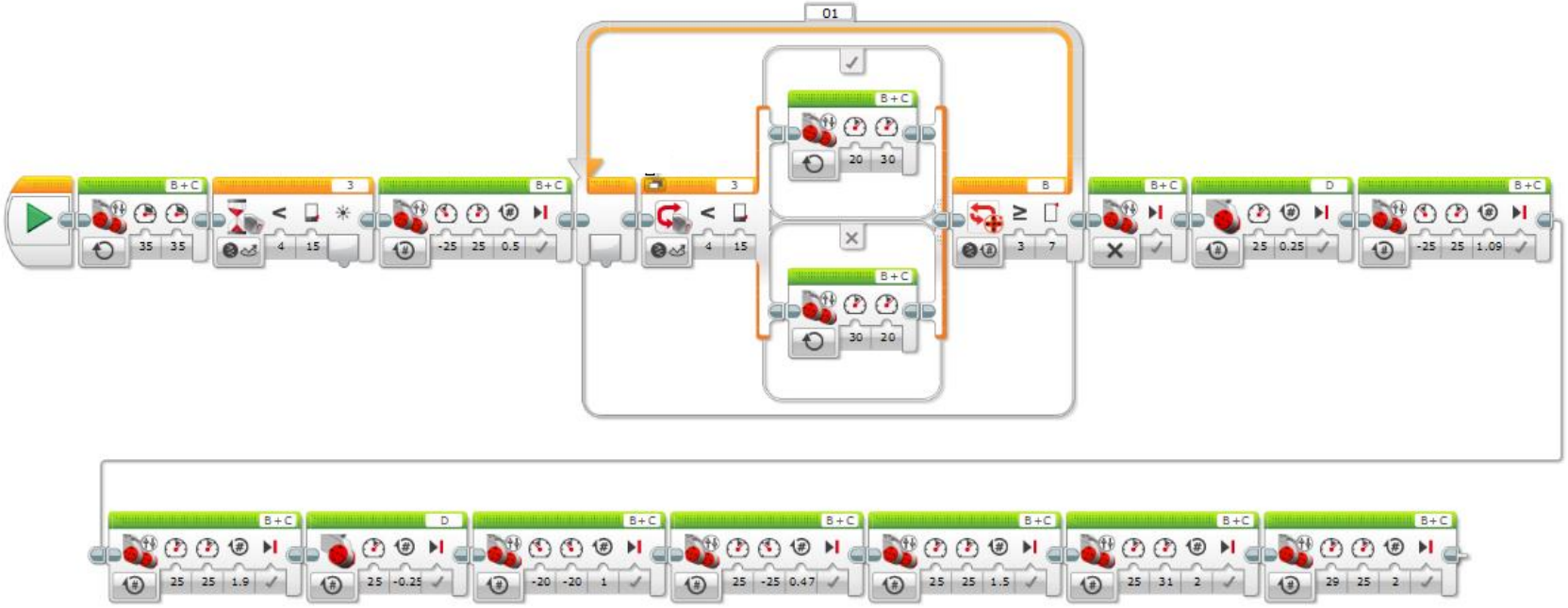
This math-oriented software can be used on a variety of complexity levels, from third graders who are just beginning to work with decimals in math class to middle and high school students who can incorporate higher math into their programs.



Lego Mindstorms Programs
by a group of
3rd graders (top)
and a group of
7th graders (bottom)

Students created programs to complete age-appropriate challenges during the Spring 2018 robotics lessons in art class.





Lego Mindstorms Program

by the 2017-18
Saint Peter Wiredcats Blue
FIRST Lego League Team

This was one of 3 programs that the team used at the NCFLL State Championships on 1-20-2018. The Wiredcats Blue placed 11th of 58 team in the robot game competition.

At the NCFLL qualifier in Greenville, Wiredcats Blue won the programming award.

Members of Wiredcats Blue and Green teams helped other middle school students learn the basics of programming during the Spring 2018 robotics lessons in art class.

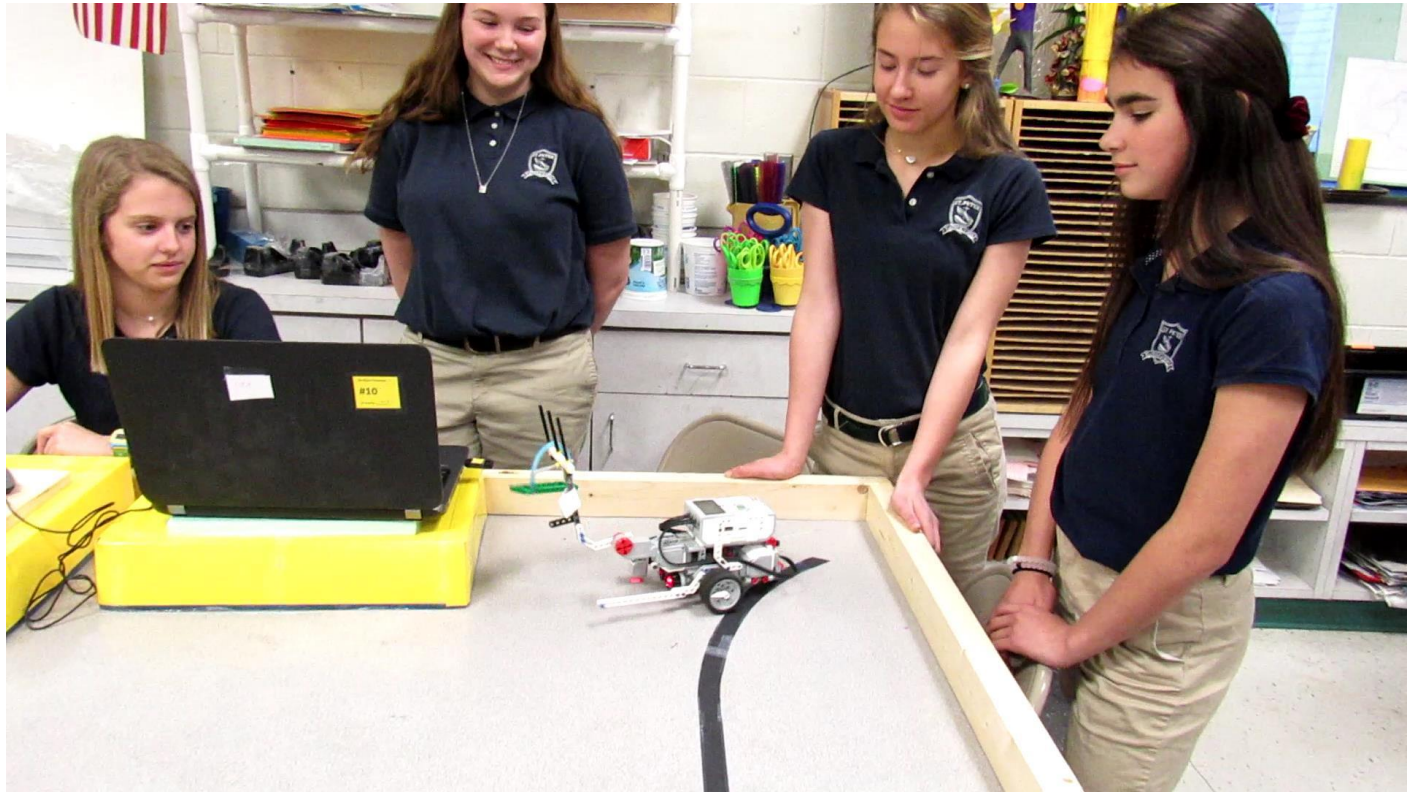
Completing Robotics Challenges

Third to eighth graders worked together to program their robots to complete challenges on a checklist.

Students evaluated the performance of their robots as they ran their missions, and made changes as needed.

Beginning challenges started with driving forward, turning around, and coming back to base.

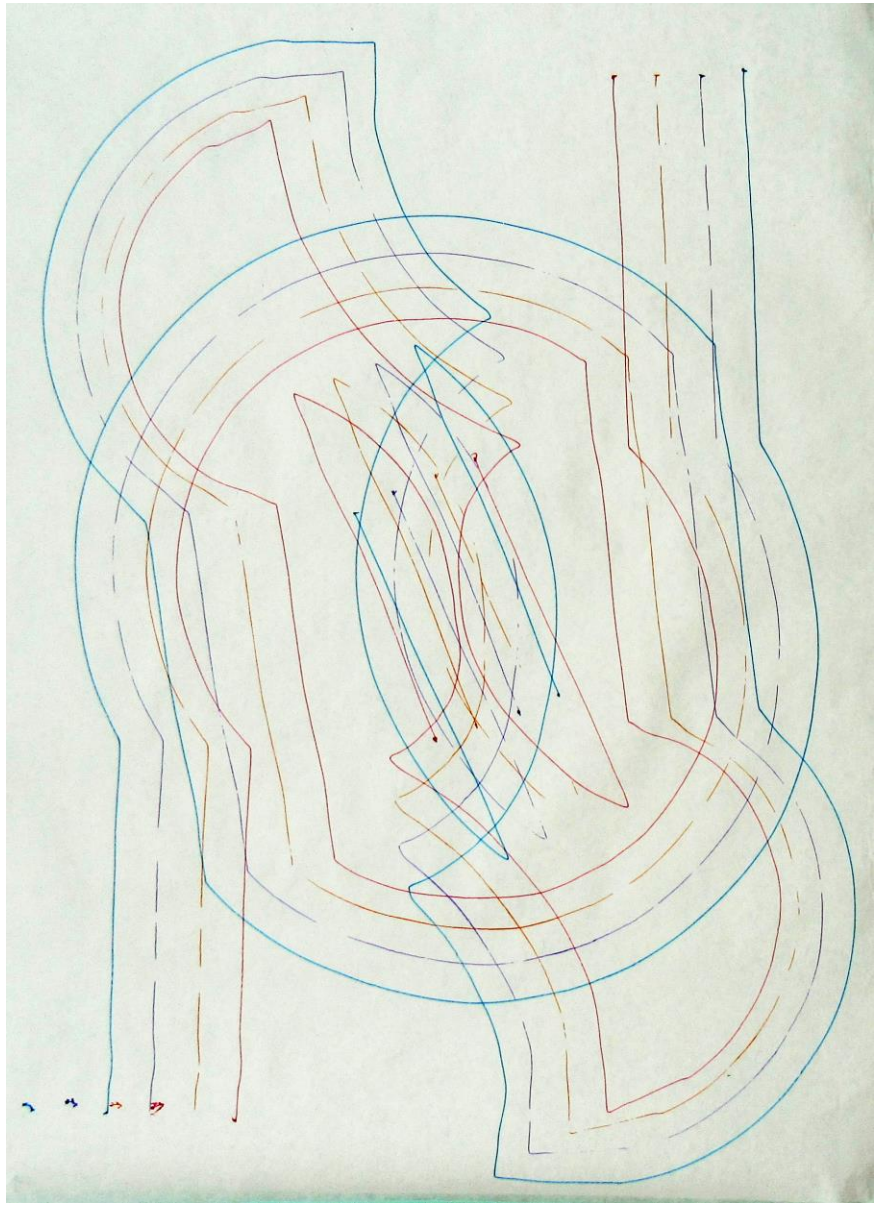
Fifth to eighth grade art students worked up to more complex challenges which involved following a black line toward an object using the color sensor, picking up the object with a lifter arm, placing the object in a bowl, and even moving another object back to the robot's starting point.



Drawing with Robots

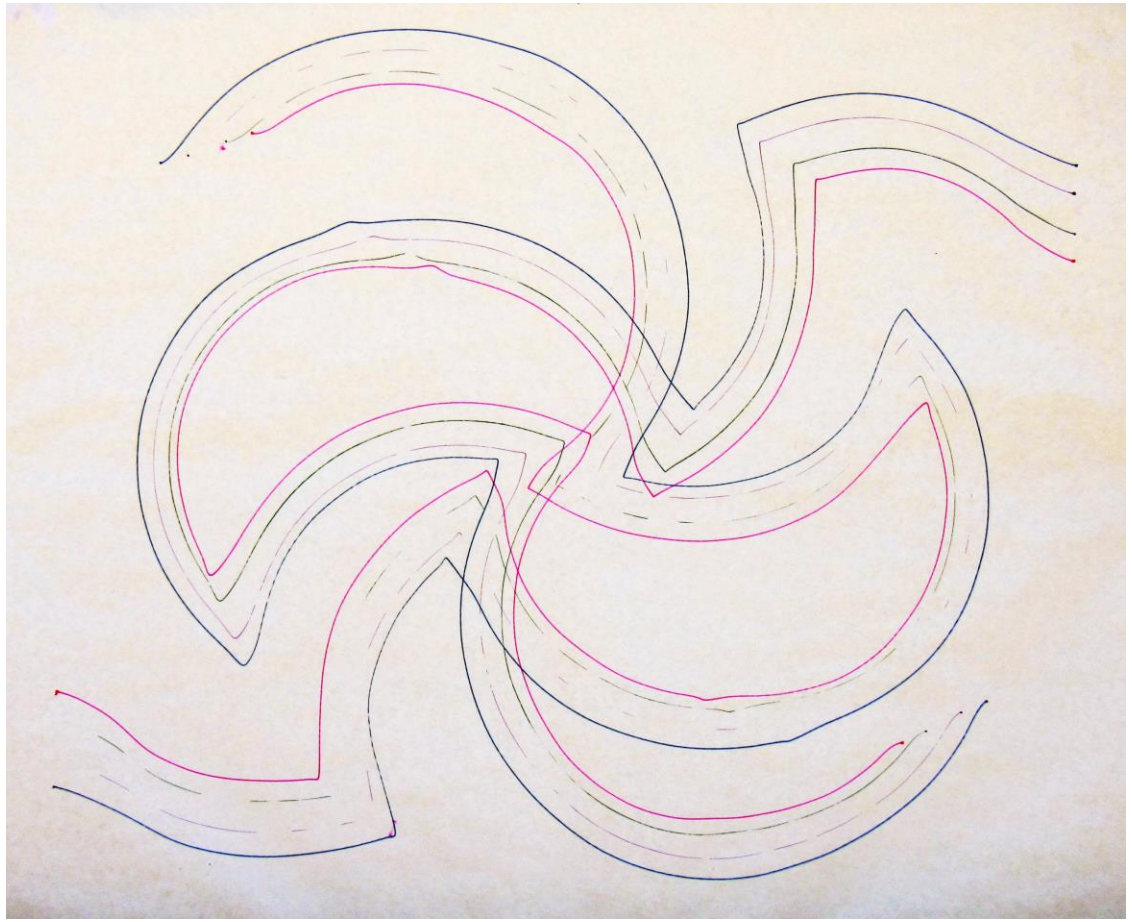
Saint Peter Catholic School's most recent innovation (Spring 2018) is drawing with EV3 Lego autonomous robots using multiple markers.

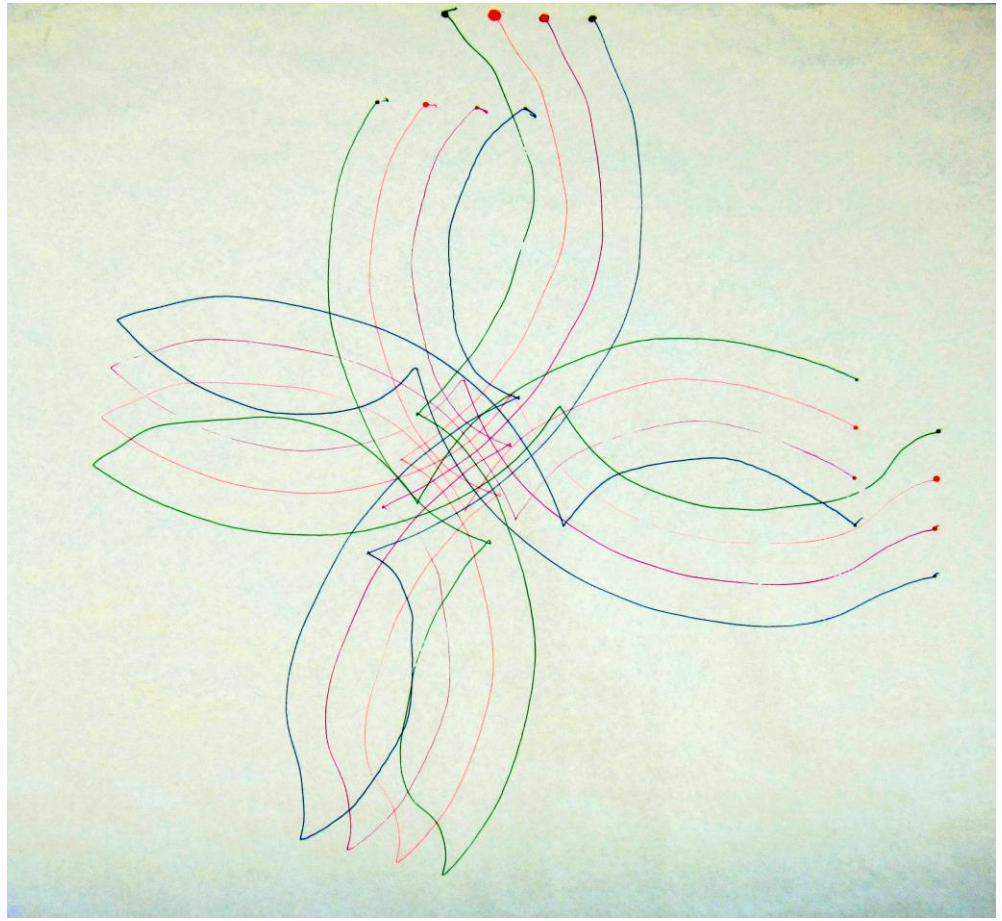
This transforms robotics from an art-related engineering activity to a creative art production activity, thus increasing the relevance of our robotics work to the art curriculum.



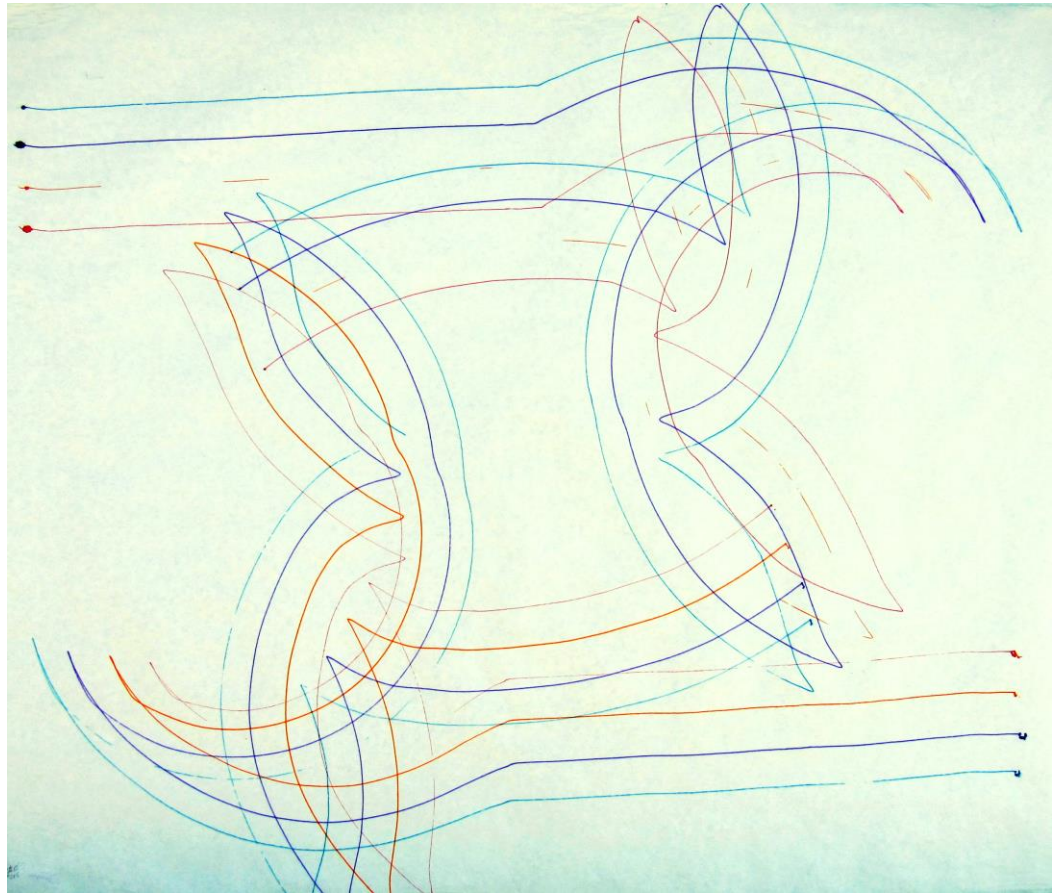
Robotic drawing by Saint Peter 5th graders (right)

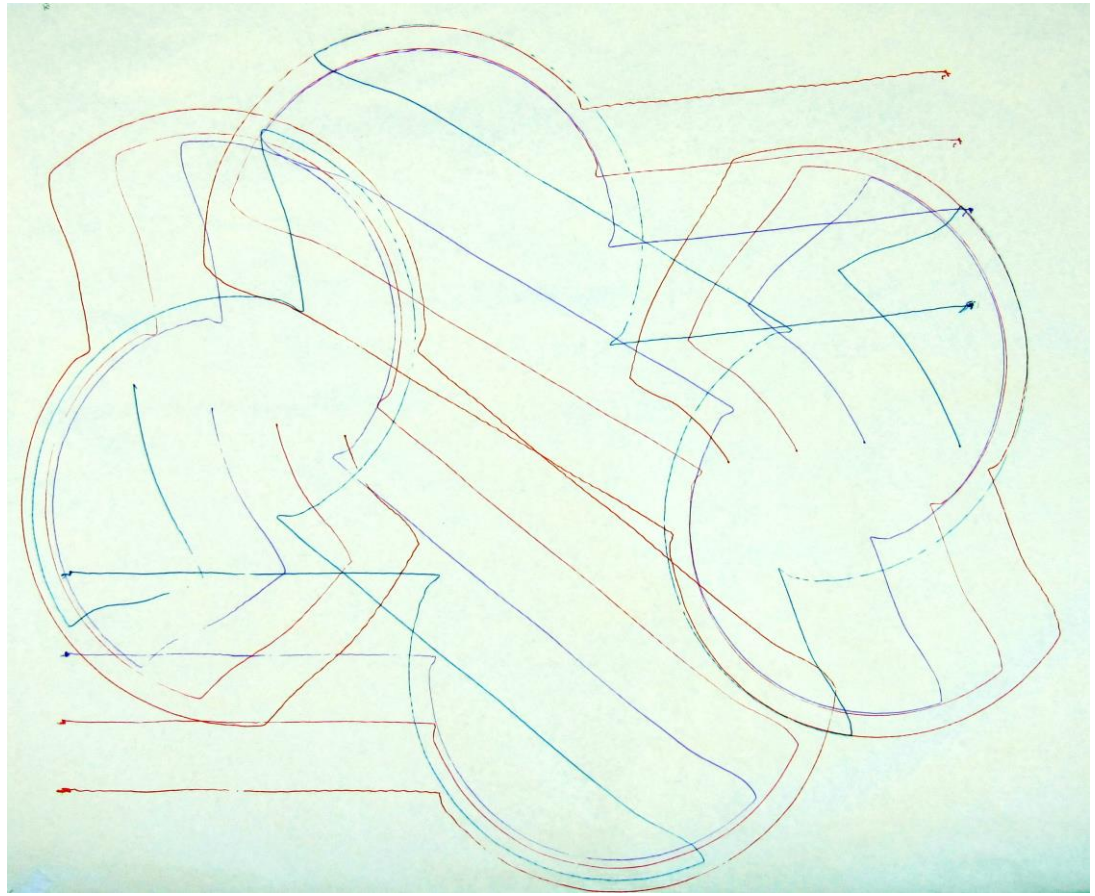
Robotic drawings by Saint Peter 5th graders





Robotic drawings by Saint Peter 5th graders





Aspects of the Robotic Drawing Process:
(1) Designing the Drawing Apparatus

Fifth graders designed and built the structures of their multiple-marker robotic drawing apparatuses.

While apparatus designs varied among the groups, certain characteristics were found to ensure that all the markers contacted the drawing paper simultaneously.

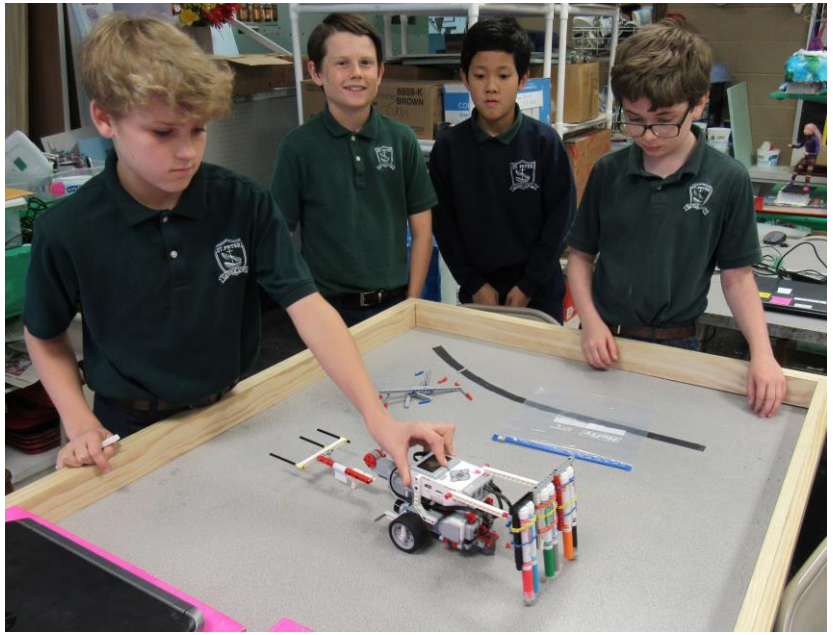
The markers needed to be generally vertical, parallel to each other, and lined up to form a plane that was parallel to the axles of the drive wheels of the robot.

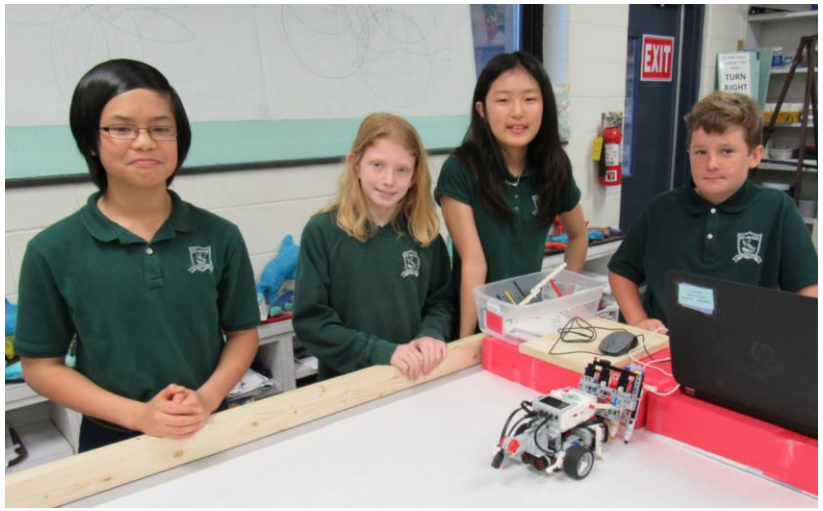
The tops of the markers (the non-marking ends) were positioned along an imaginary horizontal line that was parallel to the table top.

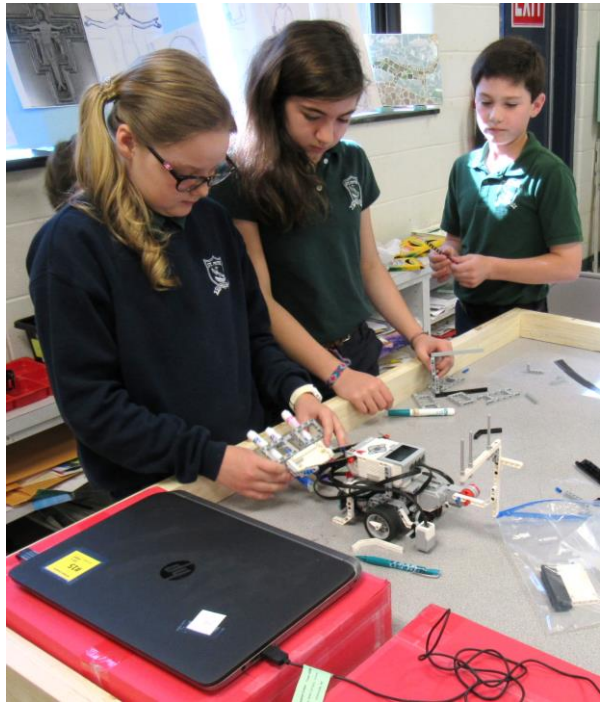
As the marker shafts are not perfectly cylindrical, they could not be held steady by Lego Technic pieces only.

Thus, rubber bands were used to secure the markers to the Lego Technic structures.

Lastly, the joints connecting the drawing apparatus to each group's "brick" (main body which serves as the power source and brain of the robot) had to be flexible so that the marking tips could maintain constant contact with the paper on the table top.







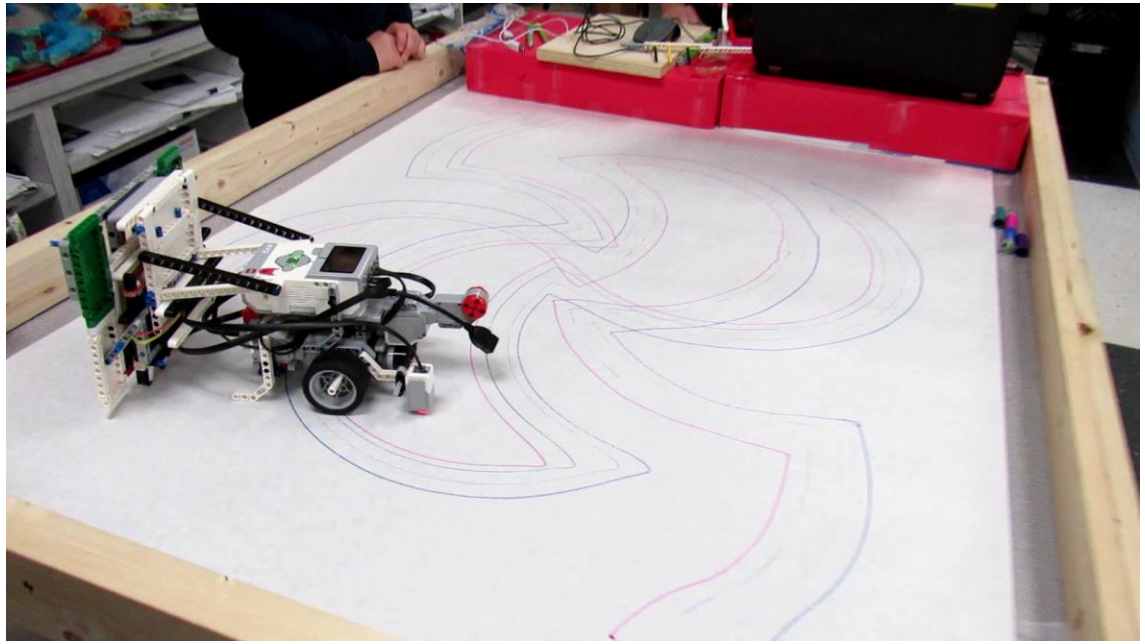
(2) Developing and testing a drawing program

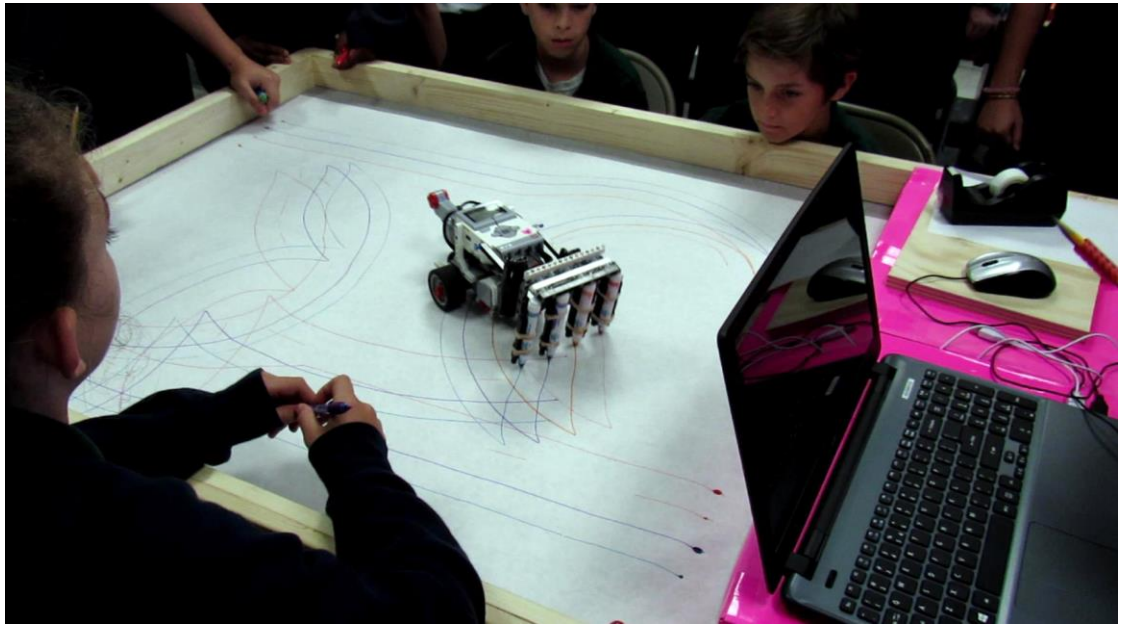
Students created designs that were generally simple and abstract. Line configurations or patterns in some drawings did resemble objects such as flowers and butterflies, but most were purely nonfigurative.

The multiple-marker apparatuses which were being pulled by students' robots were generally appropriate for designs that included sweeping arcs and straight lines.

The goal was to create drawings that (1) demonstrated their control of the programming medium through the creation of a coherent, intentional design, and (2) had a graceful, cleanly executed, integrated combination of lines and open spaces.

Early in the experimentation process, students learned that a symmetrical design could be created if they ran their designs twice on the same sheet of paper. To do this, robot runs would be started from opposite sides of the paper.





(3) Programming Robotic Drawings

To program their robotic drawing runs, each group of students used a continuous sequence of programming blocks called “move tanks” to control the number of motor rotations and the speeds of the drive motors in each segment of their design programs.

While doing test runs with the markers capped, students worked together to evaluate their programs and make changes as needed.

The programming of the drawings was technically simpler than the programming used to pick up objects with lifter arms and follow lines with color sensors.

However, when drawing, students had the additional mechanical objective of consistently contacting the paper with all the markers, as well as the challenge of creating an aesthetically pleasing drawing.

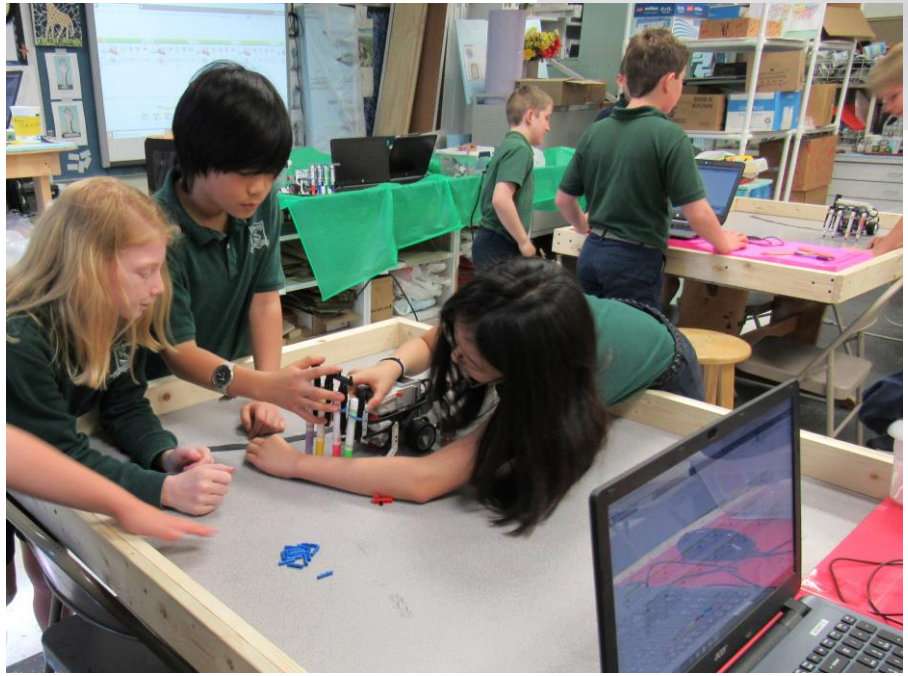
(4) Teamwork

Students within each group of three or four were strongly encouraged to take turns performing the important duties of parts assembly and programming.

Students were asked to take turns at the computer every three minutes or so, and to pass the parts being assembled to other group members frequently, so that everyone could contribute.

Most groups worked together well. However, when sharing was problematic for a group, the group was encouraged to create a written schedule for all to follow.

While individual students were programming or assembling, other students in the group still contributed their ideas verbally or performed other duties such as looking for parts in storage boxes to use in the drawing apparatus or positioning the robot on the table for a run.



Thoughts on Robotics in Art Class and Future Plans for the Program

- Students' work with robotics is intended to supplement, not replace, more traditional art class activities. Robotics is linked strongly to math and science, while simultaneously employing skill sets used in more traditional forms of visual art. As a STEAM activity in Saint Peter art classes, robotics is joining computer-aided design which has been offered to middle school students for eight years, and 3D printing, which has been offered for three.

- When students program EV3 robots with Lego Mindstorms Education software, they employ a variety of math concepts, the nature of which depends on the intent and complexity of the program. The emphasis of the spring 2018 robotics pilot program was the successful completion of various age-appropriate robotic challenges. Math learning and practice were important means of achieving success, but math concepts were not the emphasis. A principle goal for robotics instruction in spring 2019 art classes will be the development and implementation of robotics challenges that are specifically geared to reinforce concepts in the 3rd to 8th grade math curricula.

- The relative flexibility of the art curriculum and art teachers' general tendency to develop creative solutions provide the opportunity for a school's art classroom to become a hub of STEAM activity, with an emphasis on technological learning. The art program at Saint Peter, with the collaboration of faculty members from various content areas and grade levels, has been evolving in this direction for several years, and continues to do so.