Spirit 2.0

Case Study Vignettes

Vignette 1: 2nd Grade Teacher at a small private school.

Teacher A teaches 11 second grade students in a small private school in which she is the only teacher at that grade level. She attended the SPIRIT workshop in summer 2007, but was unable to attend the follow-up sessions later in the year because she was on maternity leave. She got help from UNO engineering students to make two additional robots so that she had three, and for her class she was also able to borrow an extra robot from the 5th grade teacher at her school who was also a SPIRIT Cohort 2 participant.

Teacher A arrived at her lesson idea by taking some of the lesson plan ideas generated by other teachers at the summer workshop and adapting them to meet 2nd grade standards and the interests of students at that age. She used the Tekbots in a lesson at the end of the school year and incorporated it into activities that addressed both math and social studies standards for grade two. The lesson involved the students breaking into four groups and rotating through four stations in which they did different activities with the Tekbot.

At station 1 students were allowed to just explore the Tekbot and see what it could do. They had to record three things that they observed about it. Students noted things ranging from the features of the Tekbot (e.g., it has red wires and yellow wires) and what it can do, to smaller details such as the occasions when the robot will stop unexpectedly even though the sensor did not touch an object, or the fact that the wheels gather dirt from the floor as they roll along.

At station 2 students had to use the Tekbot on the classroom's tiled floor to follow directions (one of the 2nd grade Social Studies standards). They had to make the robot move, for example, 5 tiles North and then 3 tiles East.

At station 3 students had to apply measurement using the Tekbot by timing with stopwatches how long it took on different length courses. Students had to record their results.

At station 4 students had to use their estimation skills to predict how far they thought the Tekbot would travel under certain conditions. Then they had to measure and record how far the robot actually traveled.

Teacher A found that the second grade students were very engaged by the Tekbot. She added the exploring station activity because she knew that they would want to "play" with the robot and satisfy their natural curiosity before focusing on using it in more mathematical and scientific ways. She plans to use the Tekbot lesson again in 2008/09 and will allow students even more time to explore its capabilities as well as adding graphing of the results once they have collected their data on time and distance. She continues to read the emails from the SPIRIT listserv and is

interested in learning about further development of the Tekbot platform or other robot platforms that are introduced. She regrets having missed the additional workshops on enhancements to the Tekbot, such as the remote control, and she would welcome the chance to do those if they are being repeated in 2008/09.

Vignette 2: Teacher in an Alternative Middle School

Teacher B teaches mathematics and science in an alternative middle school that serves approximately 36 students who have been removed from mainstream schools because they are designated at risk for attendance, academic or behavioral reasons. Each year about 20 students are enrolled at the start of the school year, but new students may be added at 6-week intervals over the course of the year. Teacher B decided to use the Tekbot to start an after-school robotics club that students attended by interest, rather than incorporating it into the regular curriculum.

Eight middle schools students, mainly from 6th and 7th grade, joined the yearlong robotics club. All were male students. This year there were only about 4 girls in the alternative middle school and none of them chose to join the club. Next year, Teacher B will see if she can more specifically engage the interest of the female students and entice them to join. The club brought together students who otherwise would not have naturally mixed. For example there were students present who were at the school for behavioral issues and those that were there for academic issues too. The club met once a week after school for an hour and a half. At the beginning, two students from UNO's Engineering department were assigned to help at the club. At first students worked in three small groups on soldering components, one group led by the teacher and two led by the UNO students. As the UNO student-led groups progressed faster, Teacher B decided to ask for a third student to help, and the third student joined early on.

The club was a great success on many levels. Students built three Tekbots and were highly engaged. Teacher B found that running the club was quite different from teaching in her classes and she had to take on a facilitator role and let the small groups work more independently under the guidance of the UNO students. Once the Tekbots were completed, since some students had expressed interest in programming the robots, Teacher B decided that they would do an extension project in which they added a micro controller board to the robot. About nine more students joined the club at this point. The board proved challenging to solder and attach, and even when on the robots, did not function flawlessly, and a lot of time there was only one functional robot while the problems with the two others were being troubleshooted. This was frustrating to students and some lost interest. The teacher intends to remove those boards.

There were some unanticipated consequences from the SPIRIT project in this school. The UNO students had only been assigned to the club through to December 2007 when their community service commitment ended, but they voluntarily stayed on until the class finished in May 2008. There was a strong rapport between the UNO and middle school students because they were able to relate to each other about common interests like video gaming and computers. In fact, one middle school student who had been unmotivated in regular school and seemed disinterested in his alternative school classes had a conversation with Teacher B in which the idea of him having a mentor came up. Teacher B arranged through the local TeamMates mentoring project to pair

one of the UNO students to the middle school student. The UNO student had to attend mentoring training to take on that role. He continues to mentor the student even though the robot club has finished for the year.
Another unplanned benefit from the project was that Teacher B decided to arrange a field trip to the Peter Kiewit Institute's engineering department for 15 students, some from the club, but with some others who showed an interest in attending. During the 4-hour visit, students toured the institute and engaged in a variety of activities, including a group activity.

Teacher B will run the club again in 2008/09 and has asked PKI to send three more engineering students. She is hoping that some of the 6th and 7th grade students will return for a second year, and will mix them with the new students so they can share their experience during activities. She had obtained some funding from the school's GATE and Special Education funds to purchase three or four of the CEENbot kits and they will build those. Teacher B also intends this year to think about how she can incorporate the robots into her math and science classes.

Vignette 3: Mathematics Instructor at a Community College

Instructor C teaches mathematics at an urban community college in Nebraska. He was a part of the first cohort of participants in the SPIRIT project in 2006. Since that time, he has used the Tekbot that he built in a statistics class and an algebra class that he teaches at the community college. The college attracts a wide range of students to his classes, with ages ranging from 18 – 48. Students come to the community college for a variety of reasons, some to prepare for other higher education opportunities, some for work-related purposes and some for preparing to re-enter the workforce after breaks from it for various reasons. Students vary in their mathematical experience and several are English language learners, often from other countries. So, students' expectations for the class are quite varied too.

Instructor C uses his Tekbot, which he has nicknamed "Charlie", to help students in his statistics class understand the nature of data collection and random variables. He divides his students into two teams and they construct a simple course for the Tekbot to follow. Each team member then has to use the robot's controls to steer it around the course and the time it takes is measured and recorded in a data table. At the end of this data collection there is the inevitable variation in times as some students are more skilled at maneuvering the robot than others. Students then discuss the dataset they have, which brings up issues such as what to do about that really high time that the student who couldn't steer well generated, which is a perfect example of outliers in a dataset. They go on to calculate descriptive statistics for the data. Through this hands-on exercise, students gain a strong conceptual understanding of random variables and the practical applications of basic statistics in the real world.

In his algebra course, Instructor C uses the Tekbot to give students a way to understand Cartesian coordinates and what they really mean. A grid of masking tape is applied to the classroom floor and numbered with an X and Y-axis. Students take turns at the controls of the Tekbot and each has to drive it to the coordinates called out by another member of the class. This provides a kinesthetic mode of learning about coordinates and students learn first-hand the difference

between ordered pairs like (–3,2) and (3, -2), a concept that Instructor C found students have struggled with in the past.

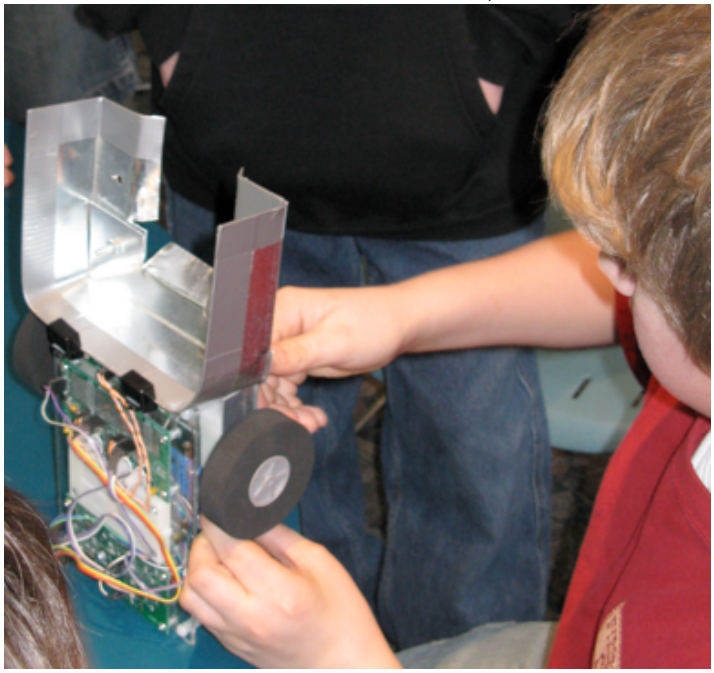
Instructor C finds that using the Tekbot in this way has helped students develop a deeper and more solid grasp of the concepts of the Cartesian coordinates system. Although it takes more time to have students work hands-on with the robot, they have a strong understanding, so that when the instruction moves on to the conventional representation of plotted points and subsequent equations, they do better in the coursework than students did before Instructor C used this method.

While Instructor C intends to go on using his Tekbot in the ways described, he has been unable to find other ways to apply them in the curriculum he is required to cover. Teaching using the Tekbot takes longer and so he has to consider the trade-off in time used for that activity with

Vignette 4: 8th Grade Science Teacher in a Magnet School

Teacher D, who was in Cohort 1 in 2006, taught science at 7th-8th Grade Science Magnet School. She had three Tekbot kits after the workshop that she had intended to have her students build, but decided to give those to a second teacher at the school who had also been through the SPIRIT training. This increased the number of Tekbots in the group of students to six, which made smaller, more viable group sizes in the class for constructing the robots. This worked well, since the students in the construction class were also students in her class anyway. Once the construction phase was completed, she got back the three built Tekbots for use with her students.

Teacher D used the Tekbots in her physics teaching to show the principles of speed, ramps and friction. Students used the Tekbots on different surfaces and had to measure, time and calculate speed. She was unable to integrate the use of the Tekbot into other parts of the curriculum because she felt it did not fit easily with what has to be taught in 8th grade science.



Teacher D created a separate class for students who were interested in entering the Robocross event, which was a part of Omaha's third annual citywide Science Olympiad. She allowed students to modify their robot by adding a scoop to the front so that they could enter the robotics competition in which they had to push as many objects as they could into a particular area in a given amount of time.

The students designed and added the scoop without input from the Teacher.

Teacher D has found that the use of the Tekbots has drawn some students out who might otherwise have not been involved in such things, including some girls. Parents have been surprised that their children have been doing soldering and regarded the experience as providing cutting-edge opportunities.

The use of Tekbots in the school by two teachers was noticed by colleagues, some of whom became intrigued enough to enroll in the SPIRIT program. Teacher D has particularly encouraged beginning teachers to get involved with the project.

In the last year Teacher D has moved from her school into the District office where she is now the lead science teacher, a position she is hoping will give her the chance to introduce more technology-based education into the schools in the district.

Vignette 5: 5th Grade Teacher in an Elementary School

Teacher E is a 5th grade teacher who was in the second cohort of SPIRIT participants. Her plans for introducing the Tekbot into her instruction were curtailed this year somewhat because she was out on maternity leave in March. She had planned to use the Tekbot to teach a lesson scale, a concept that 5th grade students find difficult, but had to postpone that until next year. However, in the earlier part of the year, she did get together with the 2nd grade teacher at her school, who also had been through the SPIRIT program, to allow their students to examine and use the Tekbots as a way of introducing them to machines and technology. She found that during the class, both boys and girls were interested in the robots, but that it was the boys who sought her out after the class to ask more questions about the Tekbot. She still refers back to her engineering notebook when students ask her questions about the Tekbot.

This coming year she would like to arrange a field trip for her students to PKI. She saw mixed reactions among colleagues at her school, with some becoming interested in the robots, while others were not. She tells interested colleagues that the SPIRIT program was very good, but also that it stretches you to think hard. One 3rd grade teacher expressed interest in attending but did not actually enroll.

Vignette 6: Computer Teacher in a K-8 Elementary School

Teacher F teaches computer classes to all grades in a K-8 elementary school, having students for only 30-minute sessions at a time throughout the day. She attended the SPIRIT workshops in 2007, as did two other teachers at her school. Together, they held after-school sessions twice a week for three months in which seven 8th-grade students enrolled. There were two girls in the class. She found that the quality of the soldering irons that were provided in the SPIRIT program was not suitable for students, since the stands were unstable and the irons got dirty. So, she obtained some additional funds from the principal, who is supportive of the project, and purchased some professional quality soldering irons at a cost of about $40 each, which has made soldering easier and safer for the students.

When the students had completed the assembly of the Tekbots, they found that they did not work, and so Teacher F arranged for the students to bring their robots to PKI where a professor helped them to troubleshoot the problem and correct it. Teacher F has since used the built robots with 3rd, 4th, and 5th grade students in her curriculum. Students work in groups of about 6-8 people and they tape a course on the floor. They take turns running the robots through the course and timing the trials in minutes and seconds, converting the measurement to seconds, entering the data into a spreadsheet, computing the average, and creating a graph of the results. Kids get very excited using the robots, which has been a little problematic, because the best space to run the robots has been in the hallway, and she has been afraid of disturbing other teachers in neighboring rooms.

The school still has 6 Tekbot kits and will repeat the robot building after-school class again this year. They would like to upgrade to the CEENbots in future because they have found the Tekbots are not very durable.

Teacher F and her SPIRIT colleagues at the school did a presentation of the Tekbots to the school board and they were well received. Some students have enquired about other programs, and Teacher F has referred them to the Aim for the Stars summer program at PKI. Parents have been interested in the use of the robots too and they seem glad that their students are getting this opportunity. She is looking into having a parent who is interested in the robots help this year.

Vignette 6: Two Middle School Teachers

Teachers G and H both teach at a middle school in which, although it is not a magnet school, they have created an elective course for 8th grade students who are interested in learning about Technical Literacy. They attended the SPIRIT training in the first cohort in 2006 and have returned in 2008 to attend the summer sessions in order to learn about the CEENbot. Teacher G is a former engineer and Teacher H is a science teacher, and they feel that their skills and expertise are very complementary. They carve out time to teach the elective class by shaving a bit of time off of every other period in the day and applying that time to create another period.

In the first year that they created the Technical Literacy elective class, they attracted 24 students. The students worked in groups of three to construct a Tekbot per team. At the end of the construction session, only one of the robots was functioning, and the teachers realized that the students needed a lot more step-by-step instruction during assembly and more quality monitoring by the teachers. They, therefore, adjusted their instructional technique in year 2 and told students that if their Tekbot did not work at the end, they would fail the class. That got the students' attention, especially for those previously academically successful students who were used to getting A's. The 24 students in the second year worked in pairs and the teachers used random assignments to pair students, forcing some to work with partners they would never have chosen. The teachers observed that pairs seemed to work very well when student who were more "bookish" were matched with student who had more practical skills. The teachers also felt that their own skills improved as they completed more workshops through the SPIRIT program, which helped them to do a better job of teaching their students. They also adopted a pattern of teaching in which they taught students about components before they used them in assembly.

They linked this instruction to the district science standards whenever possible. The student pairs worked together to construct 12 robots, all of which worked successfully at the end.

At the end of the first year's class, the teachers made a video showing the class activities, including the work with the robots, and showed that in a school assembly during National Engineers Week. After that, they got many student applications for a place in the elective class, but had to limit entry to 24 students because of budget and time constraints (they get no budget for this class). They made sure that their selection of students mirrored the cross section of students in the school, ensuring representation of girls and all ethnic groups.

Since two cohorts of students have been through their class, the Teachers are now seeing that it has influenced the students in several ways. By the end of the class, students who did not want to work with their teammate were working together productively, and girls who had been saying that they didn't think they could do it, were just as competent in all aspects of the engineering process as boys. Students from their class have enrolled in the local Technical Magnet High School and one student has emailed the teachers saying how the class had influenced her so much and that she was so grateful to have been exposed to engineering.

The elective class was featured in a video that the University of Nebraska, Lincoln made to promote a grant that they have to attract more women and minorities to engineering. This video was shown to thousands of sports fans on the screens at the Huskers football game, and Teacher G got an email from someone in western Nebraska who recognized him in it, so they are pleased that level of public awareness of engineering is being raised in the state.

Teachers G and H would like to expand their 1-year elective class into a 2-year program in which year 1 teaches the basics of engineering and technology and year 2 goes into more advanced applications like the robots. Their students have competed in the PKI robotics competition in the past, but they were the only middle school that participated, so they are encouraging others to participate. In the coming year, they will build the robots in the third academic quarter instead of the fourth, which will mean that they have built robots ready to enter competitions in the fourth quarter. They are looking at grant writing as a way to build future funds for their program.