Final evaluation report

VEX Robotics Competition in Minnesota

Prepared for

360° MANUFACTURING AND APPLIED ENGINEERING CENTER OF EXCELLENCE

Bemidji State University

May 2012

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Contents

Key Points Summary

UpFront Consulting conducted an evaluation of the VEX Robotics competition in Minnesota in 2012. The evaluation consisted of observations, focus groups and surveys. Key findings are as follows:

1. The program is largely meeting the outcomes for students around Science, Technology, Engineering and Mathematics (STEM). These are:
   - Students are developing a greater interest in robotics
   - Students are learning 21st century skills
   - Students are gaining confidence in their ability to learn STEM subjects.
2. Students also appear to be learning teamwork skills from the program, and can describe these skills in some detail.
3. Leaders and adults involved in the program are, in some cases, able to increase their robotics knowledge through teaching, although this may be dependent on the amount of robotics knowledge they have going into the program. Leaders and adults agree that they have more confidence in their ability to teach STEM subjects to students.
4. Technical colleges who participate in the program appear to be on track to attract more students into STEM programs, based on student comments and survey results. The degree to which technical colleges are able to strengthen industry and K-12 partnerships is unclear from the evaluation.
5. In looking at long-term outcomes, the program appears to be having a positive influence in creating interest in STEM education among students, and getting them to consider STEM careers. It may also be developing skills in STEM education among adults involved in the program. It is less clear what the long-term impact will be on technical college STEM programs and whether the program is having an impact on public opinions about manufacturing. This lack of clarity is largely because the evaluation design for this first year did not include components to measure these outcomes.
6. Important factors that appear to enhance the impact of the program are:
   - The competition appears to be engaging and motivating
   - Students ability to apply knowledge in practical ways is enhancing learning
   - Parent involvement in the program appears to be boosting positive outcomes.
7. Overall, students and parents are highly satisfied with the program, would recommend it to others, and find value in it, based on the amount of time they spend compared to the rewards they receive.

More information about each of these points is in the findings section of the report, following the description of the evaluation plan and methods.

How this evaluation was conducted

UpFront Consulting, St. Joseph Minnesota, conducted an evaluation of the VEX Robotics Program in Minnesota in the spring of 2012.

The program

The program is coordinated by the 360° Manufacturing and Applied Engineering Center of Excellence at Bemidji State University; five technical colleges in the Minnesota State College and University (MNSCU) system are participating.

Approximately 45 teams participated statewide this year. There were two competitions, in St. Cloud on February 18 and in Thief River Falls on February 24. Each team included a teacher or youth leader as a coach and other adults as assistants, technical advisors, etc. Most teams were made up of six to ten students. Student grade level ranges from six through twelve; some of the teams are recruited from Boy Scout or Girl Scout organizations in the state. Technical college faculty acted as coordinators in the five regions, and prepared and conducted the competitions.

More information about the program in Minnesota is available at:

http://www.sctcc.edu/vex

http://www.northlandcollege.edu/now/news/view.php?news_id=1385

Information about the 360° Center is available at:

http://www.360mn.org/

Information about the national VEX Robotics program is here:

http://www.vexrobotics.com/competition/

The evaluation

UpFront was contracted in January to complete an initial evaluation of the program. The proposal that was accepted by 360° included four components: 1) Setting evaluation objectives, 2) Team and competition observation, 3) Focus groups with teams and team leaders, and 4) Surveys of team members and adults.

A description of each of these components, as they were eventually completed, is as follows:

Setting evaluation objectives. The evaluators conducted a conference call with the project director to set formative and summative objectives for the evaluation. These objectives were then used to create the instruments used in the evaluation. As part of this process, a simple program theory was developed by UpFront and approved by 360° (see appendix for a copy of the program theory).

Observation of two team meetings and competition. An evaluator attended a two-hour scrimmage in preparation for the competition and observed two different teams. The evaluator then attended the competition in St. Cloud and observed all teams, but also spent some time with two additional teams. An observation form, submitted to 360° before the observations, was used by the evaluator.

Two focus groups. Evaluators from UpFront (one facilitator and one recorder/observer) conducted two focus groups. Participants were a mix of students and adults. The group used a pre-approved question path designed by UpFront and a standard focus group methodology. In all, 23 individuals participated; the sessions were held about three weeks after the competition.

Online survey. The survey was conducted about eight weeks after the competition. There were two versions; one for students who participated and one for adults (including technical college staff and team leaders/assistants, as well as parents who assisted with the program). The survey was designed to quantify information gleaned from the two earlier phases of the research as well as test each of the major objectives identified at the beginning of the process.

Evaluation participants

Observation—An evaluator observed four teams in some detail, about 25 students overall plus 10 adult coaches and assistants. Students and adults came and went at these observations; it was sometimes difficult to tell who belonged to which team. Three of the teams were all males; one was all females. In addition, the evaluator was able to watch many of the teams at the St. Cloud competition as they competed.

Focus groups—The first group was a team with seven students and six adults (coaches and parents). Student grade level ranged from 7^{th} to 10^{th}. All students were male; two of the adults were female. The second group was a team of seven students (an eight student couldn't attend) and three adults. All were male. Students were all in 7^{th} or 8^{th} grade.

Surveys—There were 36 responses to the student survey; 26 males, seven females, and three who didn't answer that question. Student grade level ranged from 7^{th} through 12^{th}. Students generally performed multiple roles on their team; building the robot was the largest category. In all, 11 surveyed students attended the St. Cloud competition, 21 attended the Thief River Falls competition, and three attended both (one student didn't respond to this question).

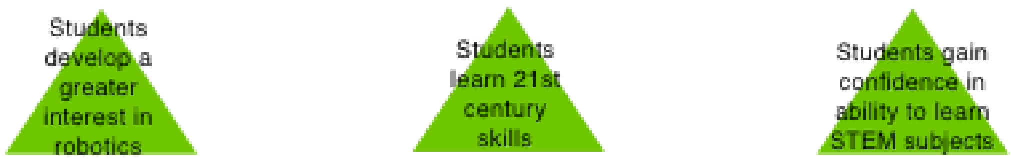
There were 29 responses to the adult survey. Asked to describe their role (they could choose multiple categories), 14 identified themselves as K-12 teachers, nine as scout leaders/assistants and even as parents. Also represented were college faculty (2), college administrators (3), and volunteers (2).

Findings

This section of the report is arranged in the order of the program theory. In each section the intermediate outcomes (outcomes that might be expected to be achieved during the time period of the program) are discussed first. Next, the moderators (factors that influence how well or completely the outcomes are achieved) are covered. Finally, findings about the end outcomes (which might be expected to be achieved after the program is over) are described.

The complete program theory is shown in the appendix to this report.

Student intermediate outcomes, skills



These three outcomes might be expected to be achieved during the time students are taking part in the VEX program. The evaluators tested these outcomes by both qualitative (observations, focus groups) and quantitative (surveys) methods.

Observations

Interest—In the observations, virtually all students showed an obvious interest in robotics. Much of the time in both the scrimmage and the competition was spent examining the machines built by other teams. There were many conversations about which design was superior at different tasks (maneuvering, picking up objects, placing objects) and why.

Skills—The evaluator observed students performing many tasks that fit into the framework of 21st century skills, such as programming and working with sensors. (For a description of 21st Century skills and how these concepts fit into that framework, see http://www.p21.org/overview). There were also many examples of students working with conventional manufacturing skills such as metal forming, working with gear ratios, measuring tolerances, etc. Not all students appeared to be working in all areas, so the degree to which this outcome is achieved is likely dependent on the student's interest in specific tasks as well as the distribution of work assigned by the team.

Confidence—Some students appeared very confident, while others seemed somewhat at sea. This was particularly true at the scrimmage; one of the teams observed never got their robot working during the entire evening and team members were not in agreement on what needed to be done. Other teams showed more confidence across all team members. The differences in level of confidence were less pronounced at the competition, but still clear that some students had gained more confidence than others.

Focus groups

Interest—In the focus groups, a number of students talked about seeing other student designs as the "best thing" about the program. One student described a "best thing" as "learning how robots work," and other students in the group agreed with this assessment. Students in both focus groups described how much they learned from examining other designs; some described how they were able to tweak their own after watching other robots.

Skills—In the list of important concepts students created during the focus groups (see appendix) they listed skills they learned from programming to construction with metals. Specific to Science, Technology, Engineering and Mathematics (STEM), they mentioned some elements that could fit into each category. For example, positive and negative charges (science), programming (technology), building within specs (engineering), and gear ratios (math) were all named. Virtually all students in the focus groups described at least one thing they learned; many students agreed on multiple items.

Confidence—Participants described how they gained confidence as the program progressed, realizing that they could build their robot and that it might work (and, in one team's case, might win the competition). Some of the adults in the focus group, who worked with the students in various capacities, were more explicit about confidence, say they watched team members (some of whom were their own children) "blossom" in the program.

In describing the program at the end of the focus group, one student summed up the experiences: "To come to this course, do all this, it changed my mind. Could change other's minds, too." He indicated he was now thinking of going on to take more STEM courses and consider a related career.

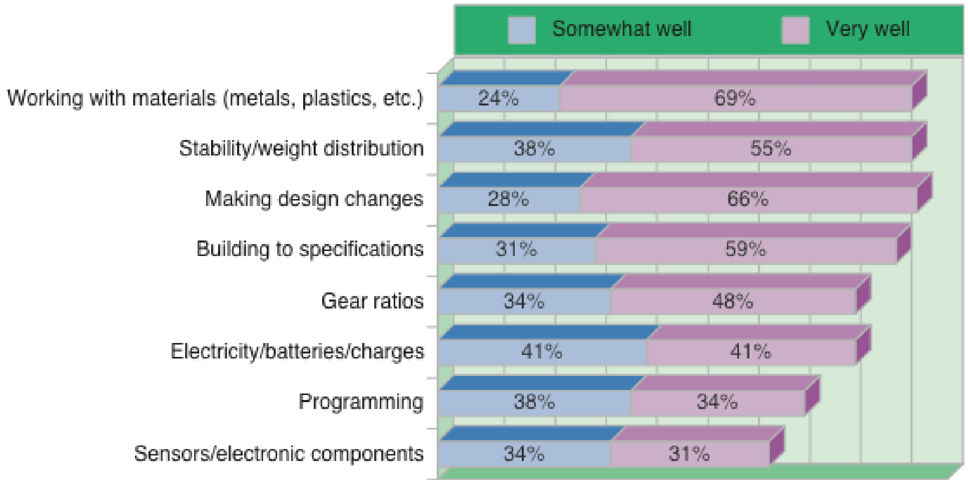
Surveys

Both students and adults involved in the program agree that these three outcomes are being achieved, based on their won experience. The charts on the next few pages show some of the data about these outcomes.

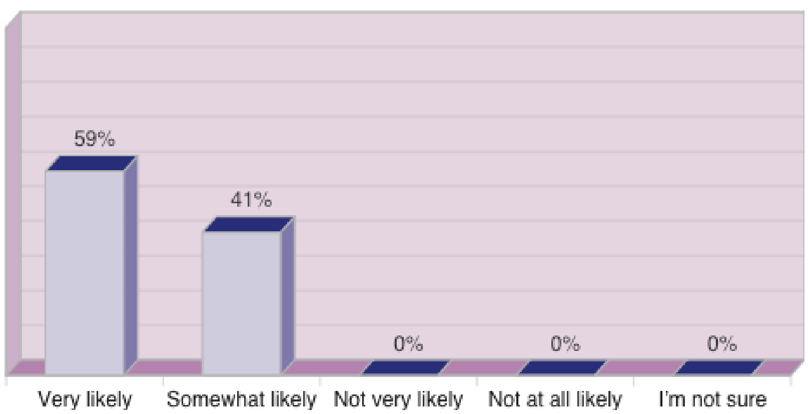
The first chart shows some of the 21st Century skills students learned from the program. The categories were created by students in the focus groups and then tested in the survey. In particular, note that in addition to more traditional mechanical and manufacturing skills, many students say they learned about programming. And nine in ten students say they learned about design changes and building to specs.

Students also report they are now more confident in their ability to learn STEM subjects.

Student surveys



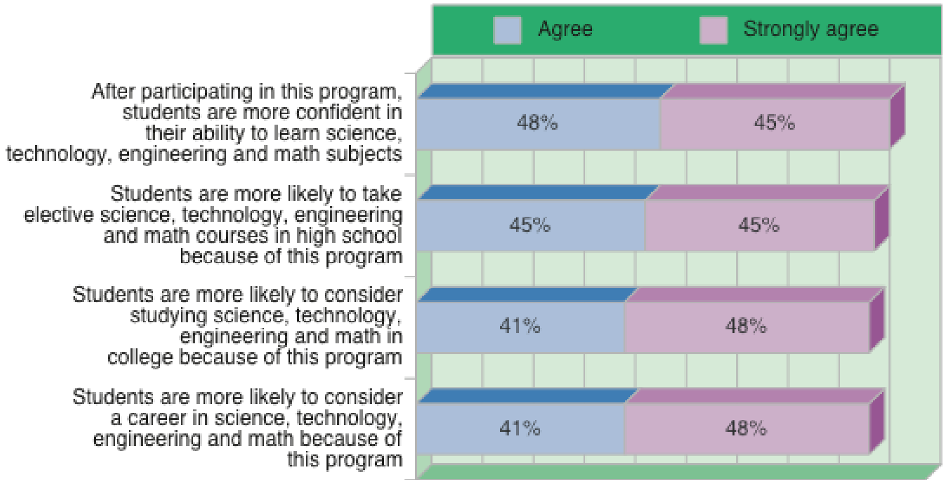
Here is a list of things you might have learned about from working on your robot. Please check a box for each one, showing how well you learned about each one:



"After participating in this program, are you more confident in your ability to learn science, technology, engineering and math subjects?"

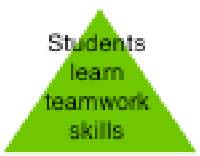
As shown below, adults involved in the program concur with students. More than nine in ten "Agree" or "Strongly agree" that students are more confident in their ability to learn STEM subjects thanks to the program (top bar in the chart).

Adult survey



"Here are statements about student experiences in the program. For each one, please tell us if you agree or disagree."

Student intermediate outcomes, teams



This outcome might be expected to be achieved during the time students are taking part in the VEX program. The evaluators tested this outcome by both qualitative (observations, focus groups) and quantitative (surveys) methods.

Observations

In the observations, students showed various levels of teamwork. In the scrimmages, one team showed very little, with individual students working on tasks without much seeming coordination (although this could have happened before the observation). There was little evidence, however, of working together.

The second team at the scrimmage worked well together. At one point they were all down on their hands and knees around the robot making suggestions about how to improve performance before the next scrimmage.

At the competition, one of the two teams showed a high degree of teamwork, with participants generally listening carefully to each other (and especially to the student who took the lead role), and making group decisions. The second team observed had two strong members who appeared to make most of the decisions; the rest mostly observed and followed instructions given by the lead members.

These two patterns were seen in other teams at the competition as well, with some showing a high degree of teamwork and others appearing to work more individually.

Focus groups

One of the questions in the focus groups asked the students to create a list of what they learned about working as a team. The lists created by both groups are shown in the appendix.

The first thing mentioned in both groups was how to divide up the work. In one group this was managing the "standing around" time, since "only so many hands can work at once." An adult in this group agreed that students learned this skill quickly, dividing up the tasks and roles. In the other group, they agreed that deciding who did what "just evolved" over the course of the program. Participants agreed they took advantage of situations to assign tasks, such as who had time that week, or at whose house the robot was residing.

Another teamwork skill mentioned in both groups was conflict resolution. In one group they laughingly agreed, "It's not a compromise if someone doesn't leave angry," but also agreed that they had worked out how to manage conflict. The other team agreed that in most cases "the majority ruled," but that there were exceptions when one team member made a decision that all accepted.

A third skill mentioned in both groups was learning to solve problems through trial and error. One group member referred to this as "redneck engineering," and got a laugh, but all agreed that this was an important method of working.

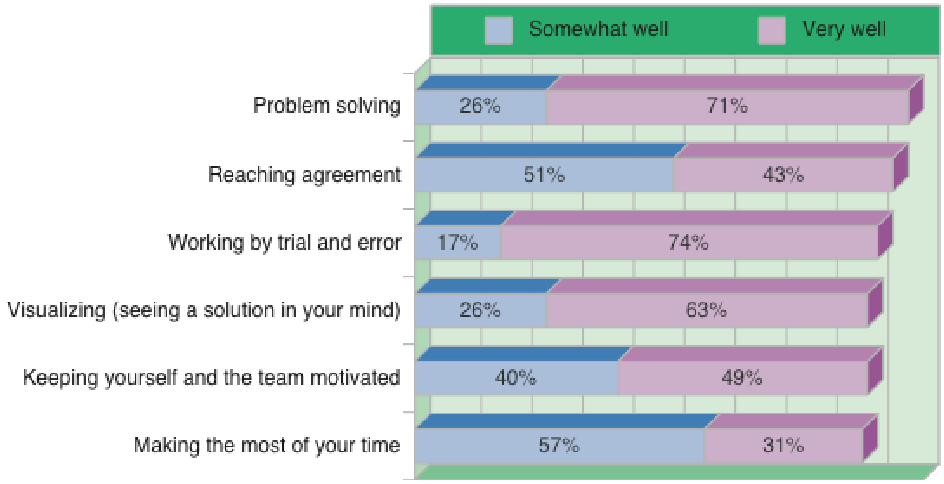
Surveys

Students reported learning a number of teamwork skills. The list of items they chose from in the surveys (for both students and adults) was created by the students in the focus groups.

As shown on the next page, both students and adults agreed that teaching problem solving skills was a strength of the program. More than seven in ten of both students and adults said students learned this skill "Very well." Also rated very highly was "Working by trial and error." Again, more than seven in ten students and adults believe the program taught this skill "Very well."

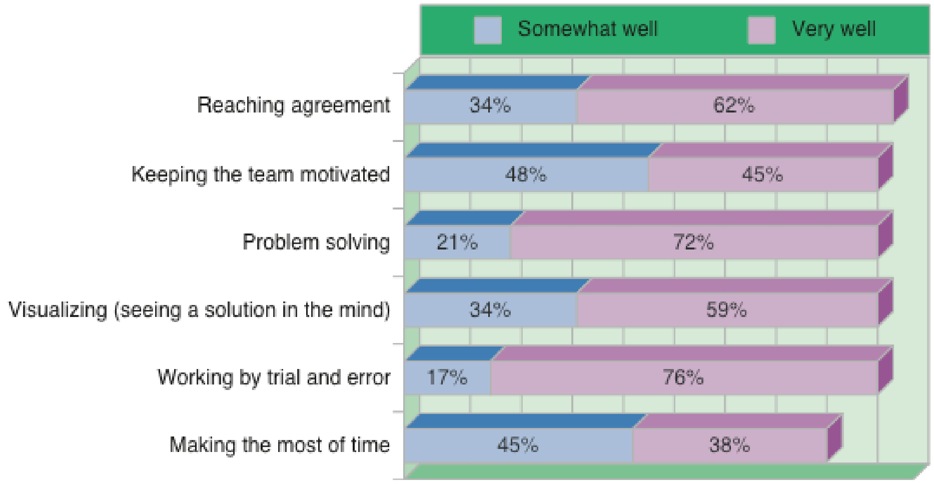
Time management ("Making the most of your time") was the lowest rated item by both groups. Still, more than three in ten said the program taught this skill "Very well."

Student surveys



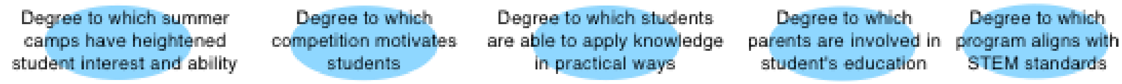
Here is a list of things you might have learned about from working with your team. Please check a box for each one, showing how well you learned about each one:

Adult surveys



Here is a list of skills students might have learned about from working with their team. Please check a box for each one, showing how well you believe they learned about each skill:

Student moderators



Moderators are program and environmental factors which influence how well or how completely outcomes are achieved. The evaluators tested these moderators by both qualitative (observations, focus groups) and quantitative (surveys) methods.

Observations

The competition appeared to be motivating to many students, by the high interest students showed in other teams and other designs, but also by the level of excitement at the event. This moderator was discussed in the student focus groups (see below).

In both the scrimmages and the competition, some students were observed applying knowledge. In some teams, there were obvious student leaders; the rest of the team looked to this individual to pass on his or her expertise. These rest of the team then were able to use this knowledge in making changes or tweaking the design and operation of their robot.

Many parents attended both the scrimmage and competition; most appeared very engaged in the process and knowledgeable. This was also discussed in the focus groups, which a number of adults, including parents, attended.

The two moderators about summer camps and STEM standards were not part of the observation plan.

Focus groups

In the focus groups, many of the students talked about how motivated they were to participate in the program again next year. For example, one said, “I will be online April 18th when they release the new competition.” Others described how they want to build a better robot next year, based on what they learned at the competition this year, both from how their robot performed and from observing other teams. It is difficult to tease out how much of this came from the competition itself, but it appears to have played an important part in student’s positive experience, especially through contact with other teams and other students.

In the focus groups students gave many examples of things they learned from the program, across all STEM areas. Their ability to translate this knowledge into useful designs was apparent in some teams. In one focus group, team members described their largely trial-and-error design method and agreed with one participant who said, “It’s not smart to build the robot right away, you have to rebuild it then.” There was consensus that it is better to “get an idea first,” then begin building.

Parents who attended the focus groups described how they were involved in the program, but not necessarily how they were involved in their child's education.

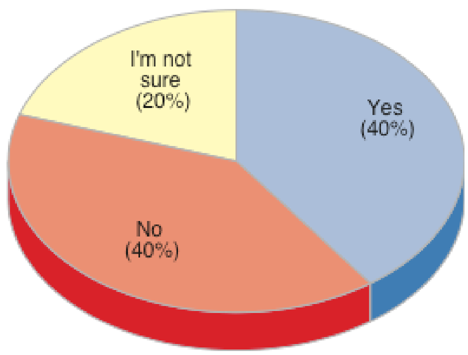
The student survey had a pair of questions about the summer camps. The camps were not discussed in the focus groups.

Surveys

A number of these moderators were tested in the survey.

The chart below shows student reaction to the summer camps. Of the five students who answered the summer camp questions, two said they had more interest in STEM subjects as a result.

Student survey



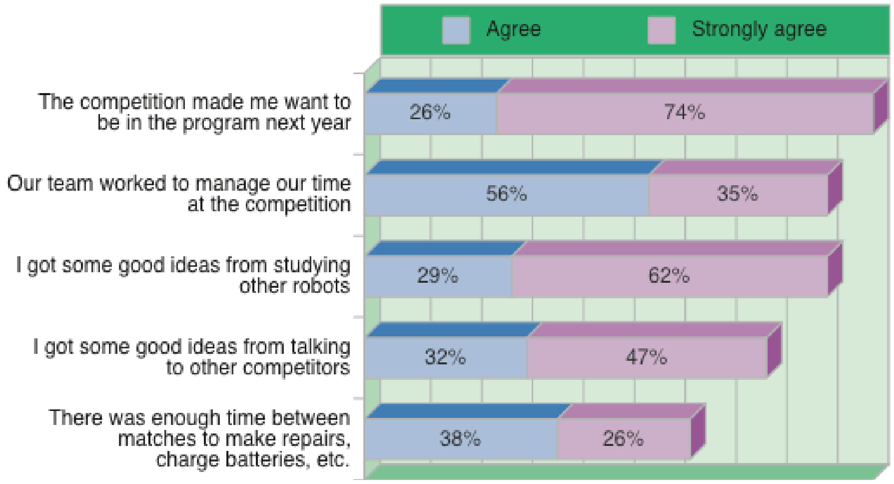
Do you think that attending the summer camp made you more interested in science, technology, engineering or math?

There was general agreement that the competition was motivating. Students were highly satisfied with the competition (see the charts on satisfaction in the appendix). Further, all students surveyed agreed that the competition made them want to be in the program next year, as shown in the chart on the top of the next page.

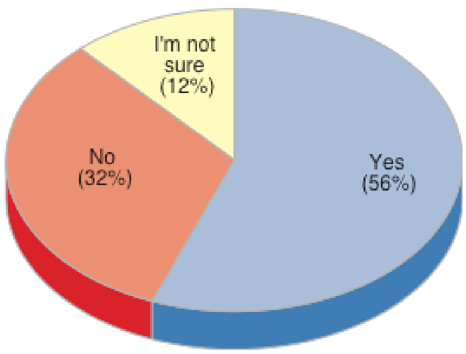
As shown in the chart earlier in this report (page 8), students rated the program highly in helping them learn to make design changes and to build to specifications—two examples of students learning to use the skills they learned in practical ways.

Although the survey didn't test parent engagement with student education, it did ask about engagement in the program. Nearly six in ten students had a family member attend the competition. Three in ten parents were actively engaged in the program by helping to build the robot; four in ten were actively involved by helping the student do research. More than five in ten helped the team plan. And most parents provided space to work and transportation for students.

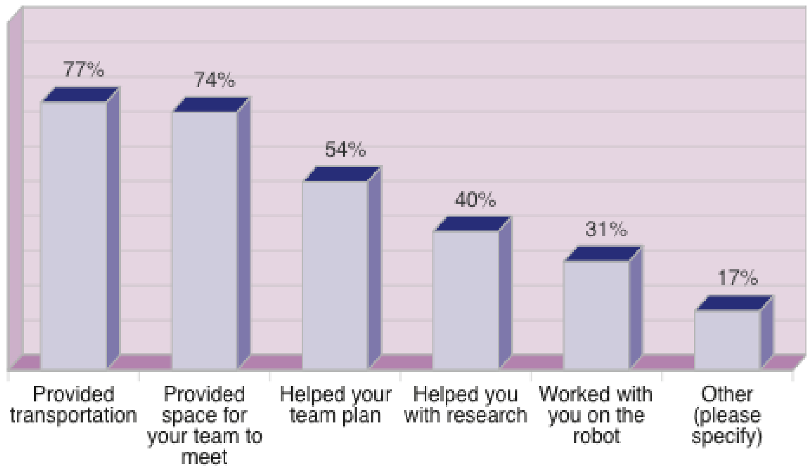
Student survey



Here is a list of statements about the competition. For each one, tell us if you agree or disagree:

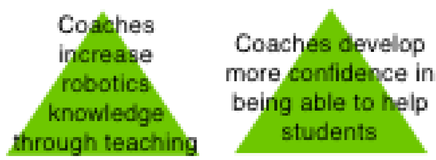


Did one or more of your friends or family members come to watch the competition?



Here are ways your parents or other adults might have helped you in this program. Please check all that apply.

Adult intermediate outcomes



These outcomes might be expected to be achieved during the time coaches and other adults are taking part in the VEX program. The evaluators tested this outcome by both qualitative (observations, focus groups) and quantitative (surveys) methods.

Observations

Increased robotics knowledge. The level of help adult leaders were able to give students varied according to their own ability. Of the two teams observed during the competition, one adult leader had taken robotics courses; the other was an IT professional but did not have direct robotics knowledge. It was not clear from the observations how these experiences impacted team performance, although the team whose adult leader had taken robotics courses did better in the competition.

Coach confidence. Observations of the confidence level of coaches was difficult at the scrimmage and competition. In all four teams (two at the scrimmage, two at the competition) the adult leader seemed fairly confident. The leader who had taken robotics courses was perhaps most confident, but all appeared to have some level of confidence.

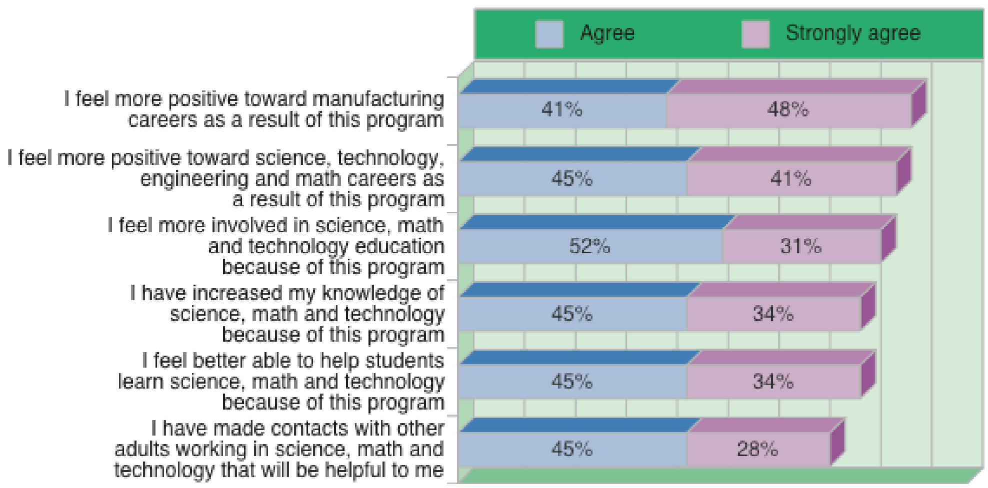
Focus groups

The focus groups concentrated on student outcomes, rather than adult outcomes. Students did not talk much about the role of adult leaders; adult leaders sometimes described their support roles but did not discuss their own outcomes. One adult did comment, "It was very rewarding to watch the evolution of the team, highs and lows leading to great teamwork by the competition. It makes me interested in leading a team again in the future."

Surveys

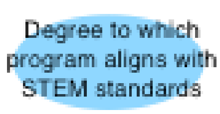
Nearly eight in ten adults agreed that they increased their knowledge of STEM subjects as a result of the program. Further, they agreed they are better able to help students learn STEM subjects because of this experience.

Adult survey



Here are statements about your own experience in the program. For each one, please tell us if you agree or disagree.

Adult moderator



Moderators are program and environmental factors which influence how well or how completely outcomes are achieved. The evaluators did not test this moderator; see the recommendations for some thoughts on how this might be achieved in future evaluations.

Observations

(Not covered in observation plan)

Focus groups

(Not covered in focus group plan)

Surveys

(Not covered in the surveys)

Institutional outcomes

These outcomes might be expected to be achieved during the time institutions are taking part in the VEX program. The evaluators tested these outcomes primarily by quantitative (survey) methods, but some of the information gathered in the observations and focus groups touched on this as well.

Observations

Attract more students. The scrimmage took place at the St. Cloud Technical and Community College (SCTCC). Students were very comfortable in the environment. In addition, SCTCC coordinated the event, and program participants had many chances to interact with SCTCC instructors and with some SCTCC volunteers. Whether this will eventually attract these students into the institution's technical programs is unclear.

Focus groups

Attract more students. The focus groups were also held at SCTCC; again students seemed comfortable in the environment and comfortable interacting with SCTCC instructors and staff. Students in the focus groups did talk about college choices, but many are still in 7th, 8th or 9th grade and didn't always mention specific institutions. However, one specifically mentioned SCTCC as a college choice. One adult in the group talked about high school students taking advanced courses through SCTCC and some students agreed they would be interested in that.

Surveys

The adult survey included five responses from the technical colleges, two from faculty and three from administrators. Highlights from these responses include:

- Three "Agree" and two "Strongly agree" that the program will encourage students to consider taking STEM courses in college, and will encourage students to consider careers in STEM areas.

- One "Agree" and two "Strongly agree" that they have made contacts with other adults working in STEM areas that will be helpful to them. The other two answered "Don't know" to this question.

Note that all five were "Very satisfied" with the program, all five would recommend the program to other students, and four of the five found it "Very valuable."

Public moderators

Moderators are program and environmental factors which influence how well or how completely outcomes are achieved. There are no identified short-term outcomes for the general public, but these moderators are assumed to influence the end outcome. (see next section). The evaluators tested this moderator by both qualitative (observations, focus groups) and quantitative (surveys) methods.

Observations

Motivating and engaging. Adult leaders working with their teams at the competition and parents who were there to help or to watch both appeared highly engaged in the process. The leaders of the two teams observed at the competition both described the day as fun and exciting for students and adults.

Parents attending. Attendance among parents and other family members (especially siblings) was good at the St. Cloud competition. The bleachers in the competition area were often completely full and many parents also toured the work areas, examining the different designs.

Focus groups

Motivating and engaging. Adults in the focus groups were as enthusiastic as the students about the competition. One adult leader said that getting ideas from other teams was a big benefit and will help the team next year. Another adult in this group would have liked more time to examine other designs; he felt that the match schedule did not leave enough time for this task. One student said, "Before (the competition), my Mom said it sounded boring. But when she was there she was not bored!"

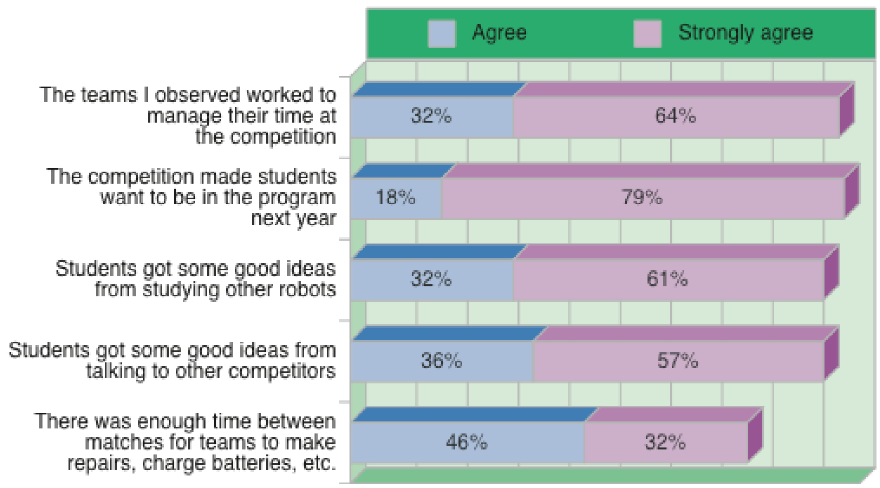
Parents attending. Participants mentioned some family members (including grandparents and siblings) who attended and indicated that they enjoyed the competition.

Surveys

All but one of the adults who completed the survey, including all parents, attended the competition. Among the students who answered the survey, nearly six in ten had a family member attend the event.

Of those who attended, all but one were satisfied; seven in ten were "Very satisfied." Further, nearly eight in ten "Strongly agreed" that the competition made students want to be in the program next year.

Adult survey



Here is a list of statements about the competition. For each one, tell us if you agree or disagree:

End outcomes

These outcomes might be expected to be achieved after the VEX program (perhaps not for many years) and are influenced by many outside factors. The evaluators looked for some evidence of progress toward these outcomes by both qualitative (observations, focus groups) and quantitative (surveys) methods.

Observations

The observations noted possible progress toward these long-term outcomes. For example:

- *Education, careers*—The high level of engagement observed among some students could lead to heightened interest in STEM education and in careers related to STEM.
- *Skills in teaching STEM*—Similarly, the high engagement of some adult leaders may lead to improvement in teaching STEM skills to students.
- *Strengthening STEM programs*—The student contact with the institution, faculty and students at the technical colleges may lead to stronger STEM programs when these students reach college age.
- *Opinions about manufacturing*—Parents and other family members who enjoyed the competition may think differently about manufacturing, especially high-tech manufacturing, as a result.

These initial observations, coupled with focus group and survey data, may be indications of progress toward these outcomes.

Focus groups

Interest in STEM education. Students were asked directly in the focus groups about their interest in STEM education. Most indicated the program maintained or added to their interest. One said, "I already was interested in science and technology, but this really sparked my interest. It's a real experience, with real technology. One of our kits was $600, most of us don't have that kind of money for kits."

Another student, who was not thinking about studying in the field, said he would probably take more science courses as a result of the experience. In the other group, six students, including one who was initially not interested in science, agreed they would take more science courses as a result of the program.

In describing the program at the end of the focus group, one student summed up his experiences: "To come to this course, do all this, it changed my mind. Could change other minds, too." He indicated he was now thinking of going on to take more STEM courses in high school.

As noted earlier, some students in one group indicated an interest in taking college courses in science and technology while in high school.

The follow-up question asked about college plans. Although most of these students were in grades 7 through 9, many of them are already thinking about college. A number indicated they would choose a school that had strong science and technology offerings. Many were not yet ready to name an institution; those that did talked about SCTCC, St. Cloud State University (SCSU), North Dakota State University, Iowa State and one of the military academies.

Interest in careers. Although not asked directly, some of these students indicated they would pursue careers in STEM areas. One said, "I want to take classes in it (robotics), even though I'm not sure I can get a job in it." Another who said the program had "changed his mind" was now looking for a science career.

Adults in the group believe the program is moving some of the students toward a career related to STEM. One said, "(Name of student) was looking at baseball…this gives pursuit for a college degree that leads to a job." Another adult, who has a technology business, said, "It is a wonderful program, gives the boys a fun exposure to science, gets them jazzed about it. And good to know there may be people I can hire in the future."

Coaches develop skills. Adults in the focus group primarily focused on the impact the program had on students. One did note, after describing the positive changes he saw in his team, "It makes me interested in leading a team again in the future."

Tech colleges maintain and enhance programs. As noted earlier, a number of students described their interest in going to a college that has strong offerings in science and technology. One specifically mentioned engineering. Two students named SCTCC as possibilities; another named SCSU.

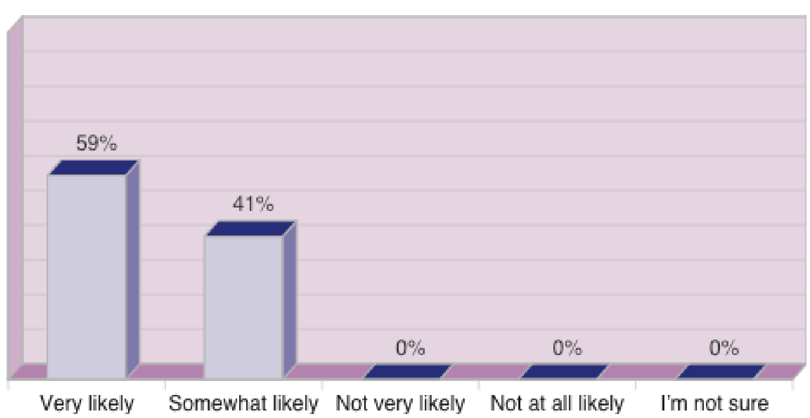
Public opinion about manufacturing. Participants described family members who attended, but none discussed whether the competition might have influenced their view of manufacturing.

Surveys

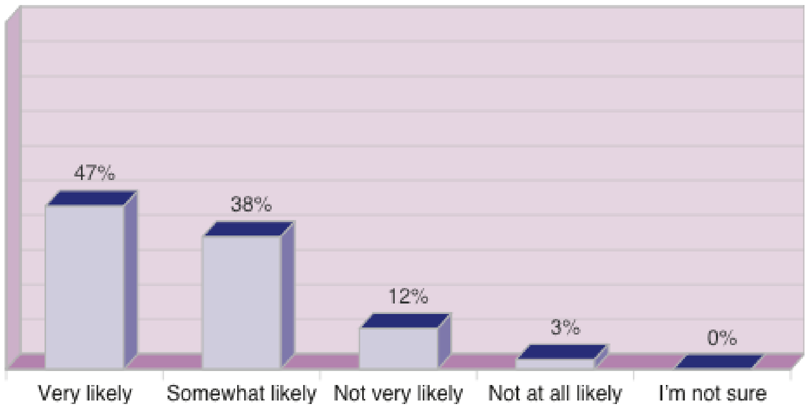
The charts below and on the next page show student responses to some of the questions around the end outcomes. Note that the evaluation looked for indications of progress toward these more long-term goals.

- Nearly all students say they are likely to take STEM courses in high school, and many will consider STEM courses once they get to college.
- More than seven in ten of the students say they are "Somewhat" or "Very" likely to consider a career in one of the STEM disciplines.

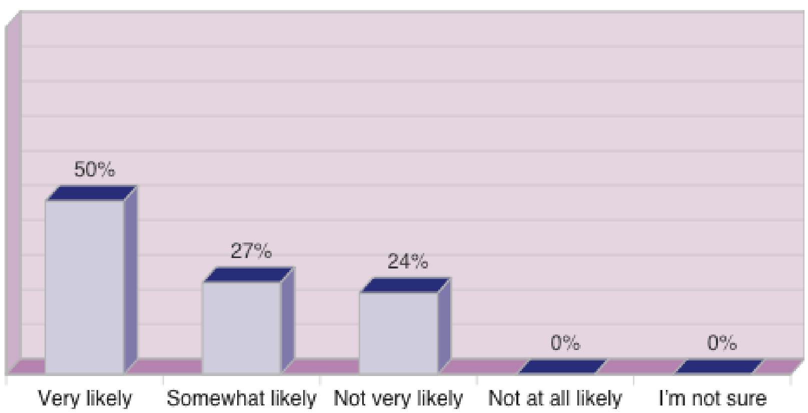
Student survey



"How likely are you to take elective science, technology, engineering and math courses in high school?"



"How likely are you to consider studying science, technology, engineering and math in college?"

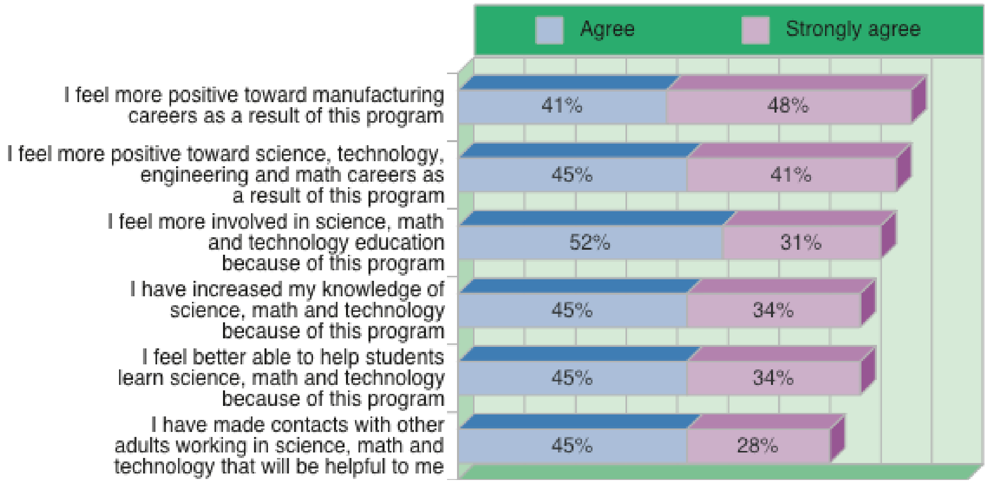


"How likely are you to consider a career in science, technology, engineering and math?"

The one end outcome for adults involved in the program is developing skills in STEM education. The chart below shows the responses to three questions, pointing toward progress in meeting this long-term goal:

- More than eight in ten feel more involved in STEM education because of the program
- Nearly eight in ten say they have increased their knowledge of STEM subjects because of the program
- Nearly eight in ten say they are better able to help students learn STEM subjects because of the program.

Adult survey



Here are statements about your own experience in the program. For each one, please tell us if you agree or disagree.

The technical colleges end outcome is maintaining and strengthening their STEM programs. As noted earlier, faculty and administrators at colleges participating in the program point to progress on two fronts:

- Three "Agree" and two "Strongly agree" that the program will encourage students to consider taking STEM courses in college, and will encourage students to consider careers in STEM areas.
- One "Agree" and two "Strongly agree" that they have made contacts with other adults working in STEM areas that will be helpful to them.

Finally, the end outcome for the general public is enhanced public opinion about manufacturing. While the evaluation did not attempt to measure the opinion of the public, the adults who are involved in the program provide some indication of progress toward this long-term goal. As shown in the chart above, nearly nine in ten adults surveyed "Agree" or "Strongly agree" that they feel more positive toward manufacturing careers as a result of this program.

Evaluation recommendations

Here are some recommendations for future evaluations of the VEX Robotics program in Minnesota:

- *Start the evaluation early.* If observation is one of the evaluation methods chosen, then observing a team from the time it first meets would be very helpful. We gathered some data this year on how the team formed and learned to work together, but the earlier this could be started the better. Also, using pre/post surveys for some of the STEM knowledge and opinion areas would be a more robust evaluation design.
- *Embed the evaluation in the program.* Set the expectation of all adults and students that completing surveys and participating in observations and focus groups is part of the program. It is important that they see a benefit to themselves in participating. For example, explaining why they should participate should go beyond saying that that an evaluation will help improve the program. It should also explain why a larger, improved program will help students, adults and their youth organization or school.
- *Include more institutional input.* A weakness of this evaluation was lack of input from the technical and community colleges. Phone interviews with administrators and faculty could be part of the evaluation design to gather more in-depth information.
- *Consider getting input from the general public.* A short questionnaire filled out by competition attendees could help flesh out the general public strand of the program theory, if this is an important outcome for the program.
- *Add more formative components.* The evaluation this year was largely focused on gathering summative data (although there were some formative questions in the survey, summarized in the appendix). As the program grows it may become more important to gather information that will help the program operate smoothly.
- *Make explicit the education standards that the program is intended to address.* Team leaders and coordinators should be given a list of the Minnesota Education Standards the program intends to address to help them help students make connections with material they are learning back in the classroom.

Appendix Tables created by students during focus groups

Group one

Learned about technology

Gear ratios

Positive and negative charges

Stability

Weight distribution

Programming

How far wheels travel per turn/math

Counting/adding segments of the track

Learned from working on team

Work distribution

Agreement on same idea

Visualize what you're thinking

Problem solving

Staying calm

Cheering each other on

Trial and error

Scheduling

(Communication, respect, responsibility, honesty, patience)

Group two

Learned about technology

Omni wheels

Construction with metals

Gear ratios

Building within specs

Programming in C

Get an idea before you start building

Learning from working on team

Standing around/managing the job

Not a compromise if someone doesn't leave angry

Ideal size of team (nice to have less than 8)

Dependence on each other (i.e. on programmers)

Design changes

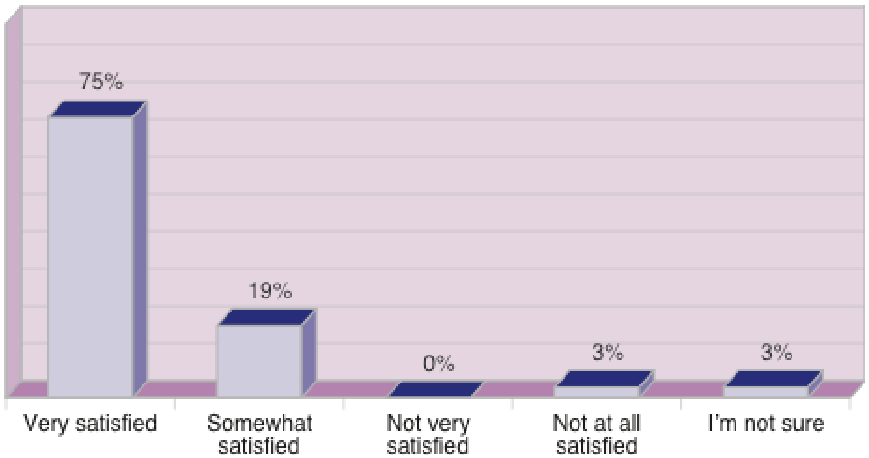
Less thinking, more trial and error

Time management (esp. in competition)

Additional formative questions from the surveys

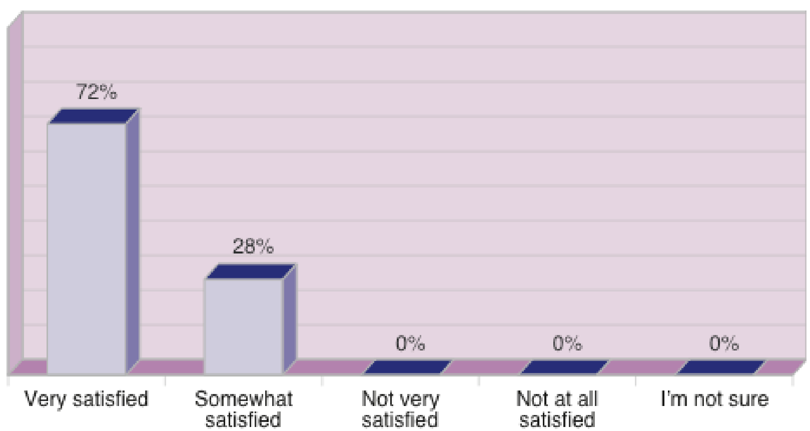
Overall satisfaction

Student survey



Overall, how satisfied are you with the VEX Robotics program?

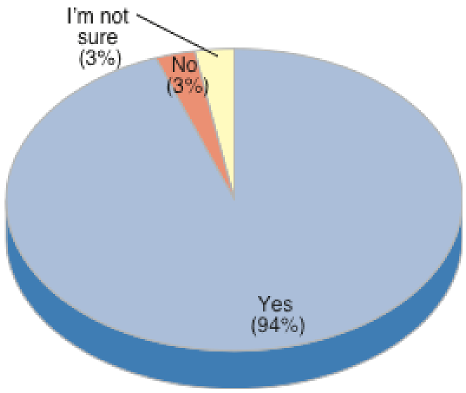
Adult survey



Overall, how satisfied are you with the VEX Robotics program?

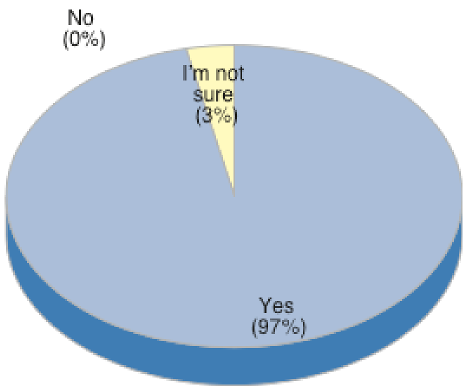
Willingness to recommend

Student survey



Would you recommend this program to other students your age?

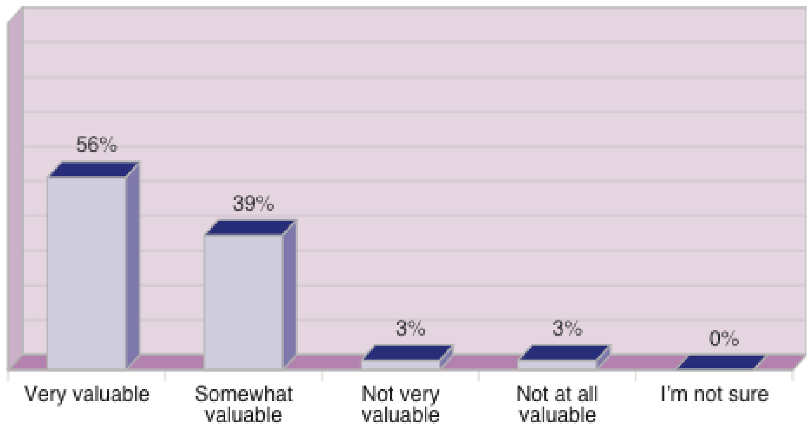
Adult survey



Would you recommend this program to those looking for youth programming?

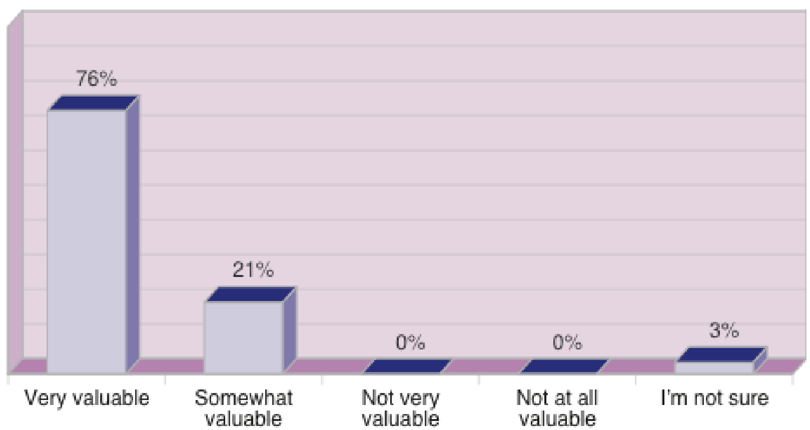
Value

Student survey



Thinking about the amount of time you spent on the program compared with what you learned, how valuable was the program to you?

Adult survey



Thinking about the amount of time students spent on the program compared with what they learned, how valuable was the program?

Other skills learned, STEM subjects

Student survey

What other things did you learn from working on your robot?

Imagination for building designs. it helped me be more creative.

I learned the ability to recognize a problem and fix it before it affects the performance of the robot

To learn from mistakes and to make adjustments as needed and to listen to everyone's input.

Leadership, running the group, barking commands and keeping everything in check.

Come up with a specific design BEFORE you start building!!

Everybody has to come to a happy median. Not everything everyone wants will be put into it.

I learned teamwork and how to be a good leader.

How it works like lifting things

How to build the hole robot.

Teamwork LEADERSHIP! Dedication courage and a bit more patient with the boys and time management

The boys were paired up and each team had a part to design for the robot then they presented it to the team for them to build the robot

Deadlines. How to find information to build the robot.

Adult survey

From your observations, what other science, math and engineering skills did students learn from working on their robot?

Problem solving skills in math

Technical reading, Internet research, hands on skills,

Physics, geometry, programming

They were forced to make changes to their robot when it didn't perform the way they wanted it to and not become so entrenched in their design that they were blinded to changes.

They learned what worked and what didn't work. They learned trial and error, and just when they thought they had it figured out, they made it to competition and their eyes were opened to new ways of doing things that they hadn't thought of

Educational opportunities,

Teamwork, scheduling, planning, estimating, working with tools, cooperation, compromising

My son was only limited by team members not including him or doing things on their own or by his own lack of participation.

Mechanical engineering. The physics of how the robot works and what actions it needs to perform. (Do you want to grip the ball in the middle, or slightly lower so it will stay in the claw?)

Some of the team didn't think they were smart enough to really contribute, but made the effort to join and discovered they had awesome ideas with the only limitations being the amount of materials in the kit!

Keeping an engineering journal

Problem solving

How to put the above aspects into a team relationship.

Patience, coming up with the final design and having all the kids to agree on it. Forming a true team of young men and having them end up like true brothers at the end.

Communication, problem solving, teamwork.

Other skills learned, working on a team

Student survey

What other things did you learn from working with your team?

Teamwork and distributing the work among everyone pretty equally.

Getting along and keeping a positive atmosphere.

Leadership roles, working as a group

We need to discuss designs more.

How good they work with electronics

Leadership

It's hard to work as a team.

Each boy has different ideas some good some bad people are busy hard to plan

We can get along.

Adult survey

What other skills did students learn from working with their team?

Mechanical hands on skills

Communicating ideas to each other in a respectable way

Compromise and leadership

Interpersonal, verbalization, communication

Let's just say…next year will be different and I will set an age limit and not have 11-12 year olds on the team

Not only visualizing, but also describing to the rest of the team their resolution to a problem. (Teaching) Responsibility, commitment, and the importance of attendance. Flexibility, as in even though you like the first design you must be willing to rework it to make it better or even give it up altogether and start over.

The team had a sense of accomplishment and was very proud of their creation!

Diversity

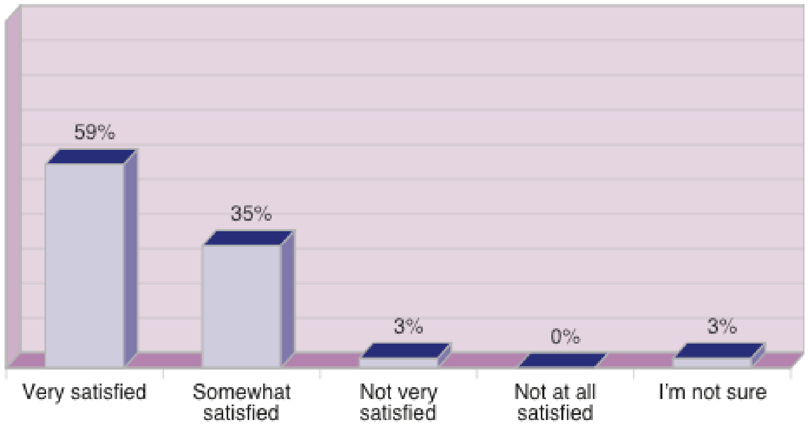
How to get along with each other when they may not be around each other any other times.

When things didn't go as planned that the team was there to support one another.

Communication skills

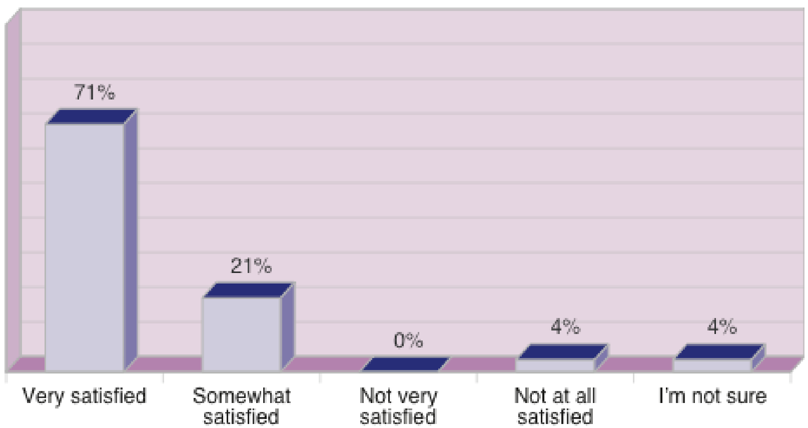
Satisfaction with competition

Student survey



How satisfied were you with the competition?

Adult survey



How satisfied were you with the competition?

Suggestions for improvement

Student survey

Thinking back from when you first unpacked your robot kit through the competition, do you have any suggestions for how the program could be improved?

Some more extra parts.

More parts

A more variety of materials to build the robot. More of each piece. Maybe less expensive?

Maybe more supplies for a cheaper price

I would like to see us being able to make more modifications and a few less restrictions on what we can do

I guess the only thing that frustrated me was that we weren't the luckiest team when it came for drawing for alliances at the beginning to say the least.

No.

Try to give more ideas of robots that could be used.

More time, and better equipment

Have more metal pieces in the pack and have all the same size screws and have a tool to cut the metal with

No. It was very good, but having more parts and time would have helped a lot.

Have a little more organization

Keep everything together and don't lose anything.

The only thing I had a problem with is the space on the small tables we had.

No

Nope

Programming the robot should be a little less complicated

I liked the program and also like that when you got your kit it gave us instruction to build the base but other then that we build it from scratch

More shafts because they break really easy!

I feel that the instruction could have included the digital inputs not covered in the tutorial.

N/A

It was such a great experience all around!

Have the arena up on the same day you get the kits. Because we didn't know what we were up against for awhile

Start earlier

More time to absorb the whole process from start to finish. We got the robots late in the game but it was very fun, interesting, enjoyable for boys from 11 to 16 plus us adults were very satisfied with the outcome even though we didn't win

Overwhelmed. Didn't know where to start. Wish there was a lot more information on things worked. The program was pretty hard to learn. Don't know how the sensors worked and how to program.

Adult survey

Thinking back from when students first unpacked their robot kit through the competition, do you have any suggestions for how the program could be improved?

We got in the competition a bit late, so communication about the program could be better. We didn't know it existed while other teams were already working. Simply emailing school principles and administration is not good enough because those messages often do not get passed along to teachers that are willing to advise programs such as VEX Robotics.

Better communications to insure the team is ready and all payments and competition needs are taken care of.

No

The rules for the competition were fairly difficult to understand without seeing them demonstrated. Our students (and others) were confused by the gaining of points when we helped the competition put balls/cylinders in their goals.

More time to make robot.

Our teams in the future will put very little weight on the competition because of how it is setup. The alliance format of the competition is unfair. The alliances in qualification can cause a good team to be seeded very low due to alliance partners who do not show up or perform poorly. This dilutes the efforts of a good team, and inflates a poor team above what they truly have earned. When one of the bottom 1/4 seeded teams automatically will be a "champion" due to the format of the contest, there is a definite illegitimacy to the term "champion." All of this could be solved by eliminating the alliances. We recognize that the rules of the contest are out of 360's hands, and there's nothing 360 can do about that.

The kits, hardware, and robotics building setup is excellent and worked great. 360's efforts, organization, and inputs were fantastic, and we are grateful for them. VEX's contest format however is very poor.

The kit itself is wonderful and I think it definitely leads them through the skills necessary to design and build a robot that meets a specific challenge. My only critique this year was the idea that some teams were allowed to compete at both meets and possibly win a spot going to Anaheim. It is my belief that doing that gives an unfair advantage to teams who have a parent or coach who is able to drive them to both meets and the resources necessary to make that happen. I would like to think that socioeconomic background of the kids doesn't count in this competition but in this case it could definitely have an influence. They also have more exposure to other competitor's robots and more practice with interviewing.

I think we were underprepared for building the initial kit. Maybe more mentoring to build the basics and then let them go on their own. We had a younger group and it was a challenge to get it started

There, have been a short class time reviewing robot basics, the boys began building their machines, before understanding the dynamics. They adapted, but learning was hindered.

We started off a bit slow...had to get kids together and then the Vex Robots weren't ready! That was tough. I and kids were a bit overwhelmed with all the stuff...We didn't use 1/2 of it...sensors gears, wheels, I would've liked some pre-class programming in the summer! Still would. 1 day to program bots.

It helped to get the organizational boxes but would've liked to have more ready-made designs to follow first times through. Thanks for opening up this to our students...Competition should be a shorter day. Start in waves? heats? so not all have to be there at once! Don't line up and pick? It seemed redundant...competed twice as long?

Talk more about where to find information on line and have more contacts of people in the trades of math, science and engineering.

Age limit

We needed help with programming. We didn't even know where to start. That part is harder to learn on your own. The kit needs better instructions (like Robots for Dummies) for people who have no clue about what they are doing! (Thank goodness for mentors!) It would be nice if the competition rules could be rewritten to be more clear by someone that is less "techie". Also if they could include more information on the physical robot, like what grease can I use on a pair of linear slides? Also, teams need to realize the time commitment needed to complete the robot, although I realize this would be based on ability. Teams should also be aware that parts wear out, especially the motors. Having a couple extra on hand is a smart idea.

And on a more positive note, thank you for an absolutely amazing program! We had a fantastic time and everyone is very excited to do this again next year. The team has seen next year's game and is thinking of ideas already! I can't say enough about how awesome the program is and what it taught the team members who didn't think they were good at the STEM courses. It opened up a world of possibilities for every member. They know they can build a robot when at times it seemed impossible. Thank you!"

A little more focus on programming earlier in the process.

All rules should of been spelled out first, but I realize that the first year is always a learning curve for everyone.

Give us more time the robots came a month late

Seeing other robots outside of these competitions, the teams will need to do more with building the supplies needed to make a better robot.

Need to have better instructions as to how the materials are used. So many parts without knowing how to use. Programming was difficult to figure out. There was no clear instructions or resources to help with building. the Vex classroom DVD was not helpful. Should have a easy CAD program so you can build before actually starting with the metal. Seemed to looking for answer that should have been apart of the program.

Have previous students or adults available to help out the new students.

Continue to grow to add more teams, the feedback I received was all positive. I feel the more we get in to this the better our future will be.

Prep teams for the competition earlier. Experience is key - perhaps assign a mentor or competition videos to watch so they understand the scope of the competition.