



Colorado *FIRST FIRST* Tech Challenge Study



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Executive Summary

Our team conducted marketing research for Colorado*FIRST*, a 501(c)(3) nonprofit organization that serves students in Colorado, grades K-12, and focuses on the advancement of science, technology, engineering, and math (STEM). Colorado*FIRST* manages four robotics programs throughout Colorado, based on age and skill level:

- *FIRST* Lego League Jr. (grades K-3)
- *FIRST* Lego League (grades 4-8)
- *FIRST* Tech Challenge (grades 9-12)
- *FIRST* Robotics Competition (grades 9-12)

For the purpose of this study, we were tasked with researching the *FIRST* Tech Challenge (FTC) and measuring **current perception of the program**. Because the program had been operating under different management for the past several years, our team and Colorado*FIRST* determined that measuring the current perception of the program would be the most beneficial place to start, as Colorado*FIRST* just recently reclaimed management of the program. We determined that in order to move forward in an effective manner, Colorado*FIRST* needed to know where the program stood among participants.

Our team identified five constructs to measure perception:

- (1) Experience
- (2) Learning
- (3) Involvement
- (4) Satisfaction
- (5) Variety

After running reliability tests on the survey results of all the constructs, we determined that only three of the five constructs were reliable and good to use for the research. They were Learning, Satisfaction, and Experience. From there, we formed three hypotheses surrounding the constructs and used a variety of statistical analyses in SPSS, to include: T-Test Pairs, Correlation, and Logistic Regression. The vehicle in which we collected the data was done through an anonymous, online survey in Qualtrics. The survey contained 22 questions (20 close-ended, 1 open-ended, and 1 partially close-ended questions). The survey was distributed via email to current and past FTC participants through their coaches. Out of potentially 600 recipients, we received 43 fully complete responses and 2 partially complete responses.

Our findings concluded that Learning, above all other constructs, was of the most important to students participating in the FTC program. Therefore, our team determined that in order to continue growing the program, that Colorado*FIRST* would need to market the program in a way that highlighted the technical and useful concepts learned through the FTC program. Other findings also concluded that students want constructive feedback during the robotics challenges. They want to understand how they can perform better. They want feedback from the judges that they can apply towards their education and overall career path.

Introduction

Colorado*FIRST* is a 501(c)(3) nonprofit organization representing the global *FIRST* organization. Their mission is to inspire innovation and leadership through hands-on robotics competitions for K-12 students. *FIRST* is the world's leading child-serving nonprofit organization that focuses on the advancement of science, technology, engineering, and math (STEM). Through these competitions, students can develop their workforce skills, improve their problem-solving and time management skills, as well as increase their conflict resolution skills; making it much more than just a robotics competition.

Our team met with the Chief Growth Officer of Colorado*FIRST*, Rodger Stewart, to determine the organization's needs for this research project. He shared with us that one of the robotics competitions (FTC or First Tech Challenge) had been operating under different management for the past several years, making it difficult to maintain a pulse on the program. Just this year, Colorado*FIRST* reclaimed management of the program.

As expected, the client had numerous concerns that he wanted to address regarding the FTC and Colorado*FIRST*, to include: a) current perception of the FTC program, b) how to grow the program moving forward, and c) determining participant knowledge and interest of registering for the proceeding program, FRC or First Robotics Challenge in the future. Our team determined that focusing our research on the current perception of the FTC program would be the most beneficial starting point for this research project.

Constructs and Hypothesis Development

Constructs:

Constructs were measured continuously on a Likert Scale as well as categorically with a yes or no scale.

- **Experience:** Measuring the students' experience participating in the FTC program as well as how they sign-up, form teams, and if they have any suggestions for improvement.
- **Learning:** Measuring if there was an improvement in technical skills and if the skills learned in the program have been helpful to participants.
- **Involvement:** Measuring importance of participant and coach involvement during the program.
- **Satisfaction:** Measuring overall satisfaction rates with the FTC program.
- **Variety:** Measuring the variety of useful and technical topics covered in the FTC program.

Hypotheses:

After running a reliability test on all five constructs, we determined that only three were reliable enough to use for this research. The three reliable constructs were: **learning**, **satisfaction**, and **experience**.

- **Hypothesis 1:** *The more useful and technical topics covered in the FTC program, the more likely participants are to have higher satisfaction rates.*
 - **Constructs Measured:**
 - Learning
 - Satisfaction
- **Hypothesis 2:** *There is a high probability that current participants will join FRC next season based off the three reliable constructs.*
 - **Constructs Measured:**
 - Experience
 - Learning
 - Satisfaction
- **Hypothesis 3:** *Out of the three reliable constructs, we predict that **Experience** will be the most important for students.*
 - **Constructs Measured:**
 - Experience
 - Learning
 - Satisfaction

Reliability Results of Constructs

- **Experience:**
 - Reliable at .711
 - Cronbach's alpha was .677 (removed first question, making the construct reliable)
- **Learning:**
 - Reliable at .762
- **Involvement:**
 - Not reliable
 - Cronbach's alpha was .42
- **Satisfaction:**
 - Reliable at .828
- **Variety:**
 - Not reliable

Instrument Design

We created an anonymous, online survey through Qualtrics that included 22 questions in total, all of which, except for one, were measured continuously on a Likert Scale. We used 2 different Likert scales. We have three types of question, open-ended, close-ended and partially closed ended. We didn't ask demographic questions to participants because of age restrictions. We estimated that this survey would take approximately five to eight minutes to complete. Instead of including a lengthy cover letter with the survey, we chose to include a very brief, but detailed, explanation of our research objectives at the very beginning of the survey. We chose to do this as our sample population would be high school students (ages 14 - 18) who have very limited attention spans and we did not want to deter them from taking the survey.

Below is our Likert Scale:

#	Answer
1	Strongly disagree
3	Somewhat disagree
4	Neither agree nor disagree
5	Somewhat agree
7	Strongly agree

Sampling

Because we are measuring current perception of the FTC program, we determined that surveying participants (past and present) who have participated in the past, or are currently participating in the program, would be the most effective approach. The subjects are high-schoolers, ages 14-18, and in grades 9-12. The online surveys were distributed via email through the FTC coaches, as we were not permitted to be in direct contact with minors, under the age of 18. The students were given two weeks to complete the survey and a reminder was sent out 7 days prior to the due date. Out of approximately 600 recipients, we received 43 fully complete responses and 2 partially complete responses.

Methodology

The data collected using Qualtrics was exported to a .sav file for data testing in SPSS. Reliability test were conducted to determine the validity of the data collected against our hypotheses to test the satisfaction levels of Colorado *FIRST*. The statistical test, T-Test pairs, was used to determine the difference in means between paired constructs. In addition, a correlation analysis was run to determine how strongly the two variables are associated with one another and to see if there are positive or negative associations.

Hypothesis 1: *The more useful and technical topics covered in the FTC program, the more likely participants have higher satisfaction rates.*

When reviewing the correlations statistical analysis, we see a significance test level at (.000) when testing the constructs learning and satisfaction. Because the Pearson correlation is at .826, this means that learning and satisfaction have a high positive correlation with one another and are strongly correlated. **This means as the value of Learning increases, Satisfaction also increases.**

Correlations

		satisfaction	learning	experience
satisfaction	Pearson Correlation	1	.826	.632
	Sig. (2-tailed)		.000	.000
	N	34	34	34
learning	Pearson Correlation	.826	1	.597
	Sig. (2-tailed)	.000		.000
	N	34	34	34
experience	Pearson Correlation	.632	.597	1
	Sig. (2-tailed)	.000	.000	
	N	34	34	34

Hypothesis 2: *Current participants of the FTC program will join the FRC program next season based on the reliable constructs.*

We chose to run a **Logistic Regression** test to measure the probability that students will register for the First Robotics Competition (FRC) program next season based off the three reliable, independent variables (Learning, Experience, and Satisfaction) and FRC as dependent variable. For this, we will look at model significance in the “Omnibus test of model significance” table. Here we see the value of significance is 0.72, meaning it is not very significant. This is due to the small sample size. Then we calculated Maximum Chance Criteria (MCC). Here we took the size of the larger group and divided it by the total number in the group. That would give us MCC. So MCC for this hypothesis is 0.70. Using MCC, we calculated PCC using the formula. So, PCC is 0.58. After that we increase that number by 25% which gives us overall hit ratio. The hit ratio is 0.725. We will compare this manual hit ratio with SPSS hit ratio. SPSS hit ratio is 0.708. This validates our test is a good test. We then finish with a formula using “variables in the equation” table, which will help us to predict the future of the problem in hand. The formula is, $FRC = \text{const}(0.22) + \text{sat}(0.84) - \text{learn}(0.73) - \text{exp}(0.27)$.

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	27.653 ^a	.054	.076

a. Estimation terminated at iteration number 4 because parameter estimates changed by less than .001.

Classification Table^a

Observed		Predicted		Percentage Correct	
		Yes, I am interested in participating in the FRC in the future	No, I am not interested in participating in the FRC in the future		
Step 1	Are you interested in participating in the FIRST Robotics Competition (FRC) in the future?	Yes, I am interested in participating in the FRC in the future	16	1	94.1
		No, I am not interested in participating in the FRC in the future	6	1	14.3
Overall Percentage					70.8

a. The cut value is .500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1 ^a	satisfaction	.835	.937	.793	1	.373	2.304
	learning	-.732	.785	.869	1	.351	.481
	experience	-.269	.477	.317	1	.573	.764
	Constant	.224	3.070	.005	1	.942	1.251

a. Variable(s) entered on step 1: satisfaction, learning, experience.

Hypothesis 3: *Out of the three reliable constructs, we predict that experience will be the most important among FTC participants.*

From our many T-Test pair statistical analysis, we see that pairs 1 and 3 are significant tests in the paired differences table. When comparing this to the paired samples statistics table, we see that Learning is above Satisfaction and Learning is above Experience. From the data we see that Learning is the most important construct among FTC participants.

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	satisfaction	5.5824	34	.95647	.16403
	learning	5.8922	34	1.14510	.19638
Pair 2	satisfaction	5.5824	34	.95647	.16403
	experience	5.4608	34	1.16346	.19953
Pair 3	learning	5.8922	34	1.14510	.19638
	experience	5.4608	34	1.16346	.19953

Paired Differences

		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
					Lower	Upper			
Pair 1	satisfaction - learning	-.30980	.64487	.11059	-.53481	-.08480	-2.801	33	.008
Pair 2	satisfaction - experience	.12157	.92834	.15921	-.20234	.44548	.764	33	.451
Pair 3	learning - experience	.43137	1.03647	.17775	.06973	.79301	2.427	33	.021

Results

When comparing the results of each construct against the statistical analysis T-Test Pairs, the participants of the FTC program of Colorado FIRST value Learning above all. The construct of Learning had the highest mean above all the significant constructs tested. The sequential order of significant importance starts with Learning, then Involvement, Enjoyment, Variety, Experience, and then Satisfaction. From the data in Qualtrics in the table below, we can see that Learning has a higher average and was selected more positively than Satisfaction and Experience.

Construct	Average	Most Selected Response
Satisfaction	5	5
Learning	6	7
Experience	5	5

Regarding our initial hypothesis, the results reflect the following:

- (1) There is a significant positive correlation between the constructs learning and satisfaction when using the correlation statistical analysis. This means the more useful and technical topics covered in the FTC program, the more likely participant is to have higher satisfaction rates.
- (2) We did not see a significant test using logistic regression to test the probability that participants would join the FRC program after completing the FTC program.
- (3) The construct of learning is more important than experience and satisfaction when using many T-Test Pairs.

Additional Results

Out of the 43 fully complete responses, 74% of participants were familiar with the FRC (First Robotics Competition) program whereas 26% were not. Of those who were familiar with the program, 75% said that they would be interested in participating in FRC in the future whereas 25% said they were not interested in participating in future years. We included this as additional results because the client had an interest in knowing what percentage of participants were interested in registering for FRC in the future.

Discussion and Conclusions

Overall, participants view the FTC program as a **positive learning experience** and believe that **their technical skills have improved** from the program. We see that the majority believe **their problem-solving skills have increased** based on what they've learned in the FTC program.

A major concern of Colorado *FIRST* was to test the satisfaction levels of the FTC program. The data shows that FTC participants are **generally satisfied with the program** based on the survey results from Qualtrics. We see that there is a positive correlation between the topics covered in the FTC program and participant satisfaction. It appears FTC participants want to be challenged with high technical concepts. The more challenging and valuable the concepts are to the participant, the higher the satisfaction predicted. We see this in our correlation analysis where Learning has a significance of .000 and has a positive correlation of .826.

In conclusion, the data suggests FTC participants are generally satisfied with the FTC program, but there is room to grow in terms of increasing satisfaction levels. Based upon the T-Test pairs analysis, the information learned and the value that it provides to

the FTC participant is most important. We see that as the value of learning increases, so does the value of satisfaction in the program. **This means Colorado FTC participants crave knowledge and ultimately won't be satisfied until they believe the experience, they've learned have set them up for future success.**

Recommendations

Our recommendation is to continue to innovate on the topics and problem-solving challenges that are presented in ColoradoFIRST's FTC program. Based on our data, participants need to feel like they've participated in a positive learning experience, their technical skills have improved from the program, and that the program has improved their problem-solving skills. If these qualifications are met, ColoradoFIRST should see an improvement in their satisfaction levels.

Additionally, innovative learning concepts should be communicated in ColoradoFIRST's marketing campaigns to encourage growth of the program. Since we see a high correlation between Learning and Satisfaction constructs, crafting related messaging would entice participants to sign up for the program.

A few suggested ways of improving the learning experience are:

- Having judges give feedback during the competitions of what to improve upon, specifically regarding the engineering notebook.
- Continuing to cover useful and technical topics during the FTC program.
- Communicating the learning outcomes to students who are considering participating in the FTC program via marketing materials.