

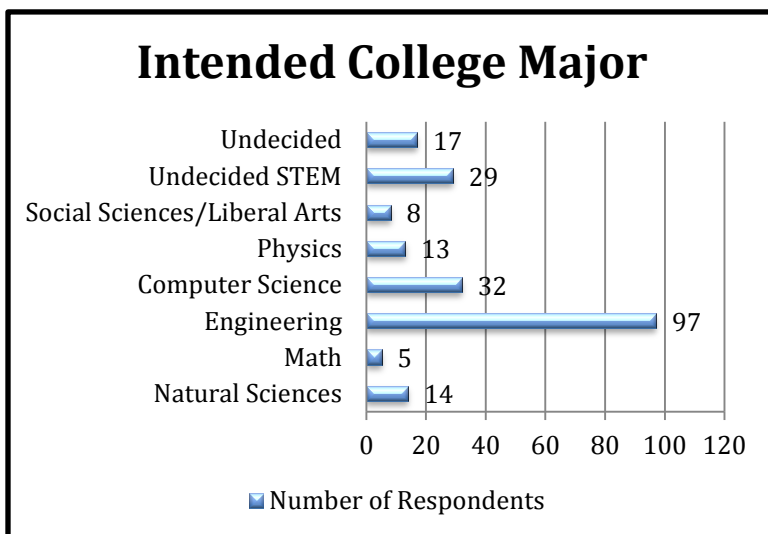
Executive Summary

ColoradoFIRST Impact on Participant Future Education and Career Choices

ColoradoFIRST and FIRST Robotics Competition (FRC®) have certainly had a significant positive impact on participating K-12 students' future education and career choices. Both influence on future education decisions and influence on future career choice are highly correlated; indicating the closely related dynamic between ColoradoFIRST and its influence on future education and career choice. ColoradoFIRST has positively influenced FRC participants to study a STEM-related field in college and graduate school, with the main fields of choice being engineering and computer science.

ColoradoFIRST influence on future education decisions can be mostly attributed to two variables: attitudes toward ColoradoFIRST as an organization, and attitudes toward the FRC Colorado Regional Competition.

The entire pool of FRC participants has indicated that they wish to attend college, but, even more astonishing is that the majority of them wish to pursue a Master's Degree or higher. Of these individuals, the majority wish to pursue a major in either engineering or computer science. This fits the nature of the FRC Colorado Regional Competition as a competition in building and programming robotics.



The desire to study a STEM-related major in college and graduate school has resulted in a desire to pursue a career in a STEM-related field. ColoradoFIRST influence on career choice is inconclusive based on this study; however, it has clearly influenced future education decisions, which in turn, have significant influence on career choice.

It was hypothesized that the level of a participant's parents' education would be related to attitudes toward ColoradoFIRST, FRC, further education, and career choice. No meaningful relationships were identified, but the following chart indicates the breakdown of students by desired degree and whether or not their parents went to college.

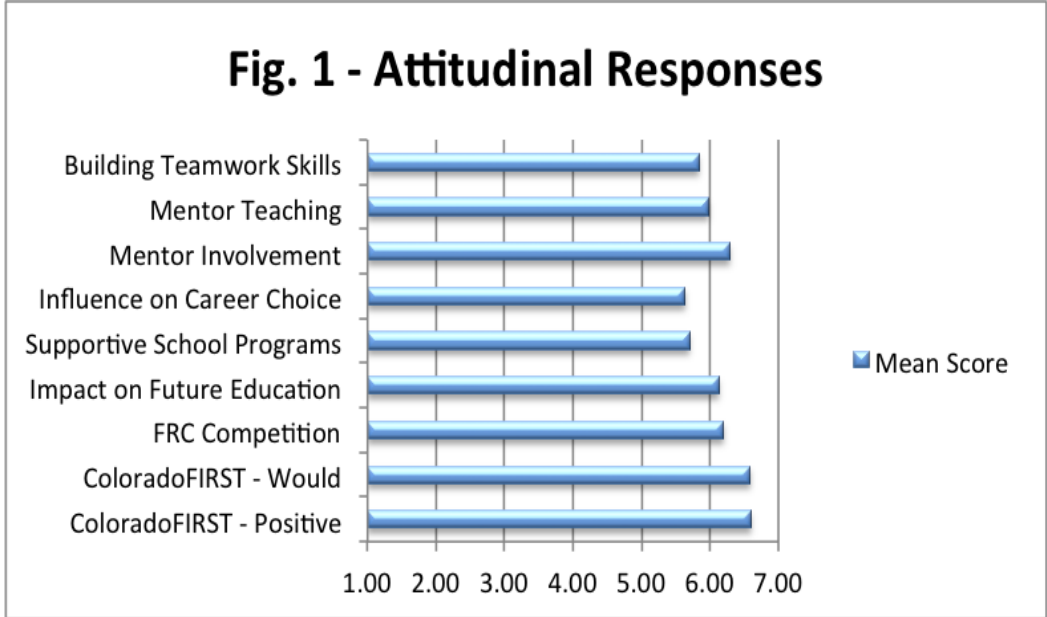
		Degree Goal			
		Associates	Bachelors	Masters	Doctorate
Parents Went to College	Both	2 0.9%	39 17.0%	70 30.6%	41 17.9%
	Father only	0 0.0%	7 3.1%	7 3.1%	10 4.4%
	Mother only	0 0.0%	8 3.5%	8 3.5%	7 3.1%
	Neither	2 0.9%	9 3.9%	7 3.1%	7 3.1%

No relationships were identified between parents' level of education and the participants' attitudes toward each construct; this is most likely due to the fact that the vast majority of participants have parents that both attended college.

Methodology

The goal of this market research study was to assess the impact that ColoradoFIRST has made on student participants in the 2012 FRC Colorado Regional Competition. In order to accomplish this, it was first necessary to evaluate the student's attitudes toward ColoradoFIRST (CF) and the following constructs:

1. The FRC competition (FRC)
2. The impact that ColoradoFIRST has had on education goals (EDU)
3. The relevance of in-school programs to ColoradoFIRST and FRC (SP)
4. The influence that ColoradoFIRST has had in deciding a STEM-related career (CI)
5. The involvement of each team's mentors (MEN)
6. The teamwork skills gained by participation in ColoradoFIRST (TI)



Overall, the mean response score for all above stated constructs was positive (fig. 1). Responses were collected on a seven-point scale with one being “strongly disagree” and seven being “strongly agree”. The questions were written to measure positive attitudes. The lowest mean score for a construct was “Career Influence” at an average response of 5.64 out of 7. The average score for career influence is still well above the natural midpoint of 4, which represents a response of “neither agree nor disagree.”

The second step in determining the impact ColoradoFIRST had on participants in the 2012 FRC Colorado Regional Competition was to identify meaningful correlations between the constructs (fig. 2). As indicated by figure 2, several meaningful relationships were identified. For these purposes, a correlation factor of between 40% and 60% is considered to be a moderate correlation, with a factor of 60% to 80% considered to be strong. The strongest correlation was between the ColoradoFIRST and the FRC Competition constructs with a factor of 60.4%. These correlations indicate that as attitudes toward each construct increases, attitudes toward the correlated construct will increase by as much as the correlation factor. In other words, the correlation factor between the ColoradoFIRST (CF) and the FIRST Robotics Competition (FRC) variables is 60.4%. This means that as positive attitudes toward ColoradoFIRST increase or decrease the attitudes toward the FIRST Robotics Competition will increase or decrease by roughly 60% of the change in attitude toward ColoradoFIRST.

Fig. 2 - Correlation Factor

Construct	FRC	EDU	CI	TI
CF	60.4%	43.9%	--	43.1%
FRC	--	56.5%	46.1%	46.8%
EDU	--	--	--	47.3%

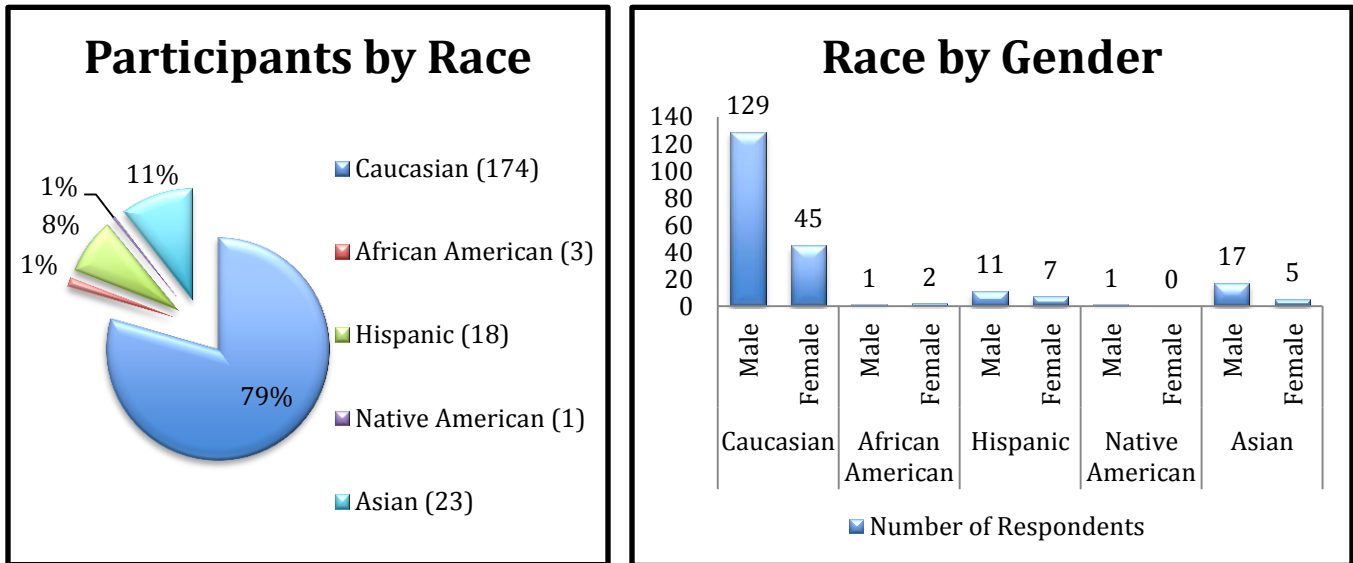
Finally, to determine the predictive nature between the constructs, regression analysis was used. This takes correlations one-step further to identify how attitudes toward each construct affect the other constructs. These findings will be explained further in the following sections.

The goal of identifying attitudes toward the various elements of ColoradoFIRST is an effort to gain a high-level perspective of the participants. This will then be used to drive further research, which will be completed at a later time.

An additional objective of the study was to evaluate the attitudes of minority and underrepresented participants. Once the above stated steps were completed, various analyses were completed to breakdown attitudes by race and gender. These results are discussed later in the report.

Demographic Data

The following graphs and tables indicate the demographic breakdown of the survey respondents.



Age data, while it was gathered, was used only to attempt to identify relationships between attitudes and age; no such relationships were found. In regard to building a demographic picture of the typical ColoradoFIRST FRC participant, age plays little role as they are all in high school and within the same age range.

Attitudinal Findings

ColoradoFIRST

To determine attitudes toward ColoradoFIRST, the participants were asked to indicate the level to which they agreed with the following statements:

1. FIRST has been a great experience.
2. I wish I had become involved with FIRST earlier.
3. I would recommend FIRST to anyone interested in science, technology, engineering, and/or math.

Overall, attitudes toward ColoradoFIRST as both a positive experience and willingness to recommend are highly positive. The construct, "ColoradoFIRST as a positive experience," held the highest mean score with 6.60 out of 7. This was followed closely by the construct: ColoradoFIRST – willingness to recommend with a mean score of 6.59 out of 7. Additionally, these two constructs maintained the lowest standard deviation

indicating that the responses were all very closely grouped and the most consistent of the data set.

Attitudes toward ColoradoFIRST are most closely correlated with attitudes toward the FRC competition. The correlation factor between the two variables is 60.4%. For example, if the average score for the ColoradoFIRST construct were to increase by 1, the average score for the FRC construct would, on average, increase by .604 and vice versa. Additionally, attitudes toward ColoradoFIRST are moderately correlated with its impact on future educational goals and impact on teamwork skills, with factors of 43.9% and 43.1%, respectively.

Regression analysis proved to be statistically insignificant; therefore we cannot determine which construct is most responsible for affecting attitudes toward ColoradoFIRST.

After comparing the ColoradoFIRST constructs to categorical data it was discovered that the only relationship exists between the students' attitudes towards ColoradoFIRST and the highest educational degree that they desired to earn. Those students that intend to earn a Master's or Professional degree recorded the highest average response of 6.75 out of 7; with a total of 92 students, the Master's or Professional degree category had the highest response rate. Overall, the average responses for all degree levels were quite positive.

All other categorical data proved to be statistically insignificant when assessing an attitudinal relationship toward ColoradoFIRST. This was not unexpected as participation in ColoradoFIRST is voluntary and its participants most likely maintain a preexisting appreciation for, and proclivity towards, STEM related activities.

FRC Experience

To determine attitudes toward the FRC Colorado Regional Competition, the participants were asked to indicate the level to which they agreed with the following statements:

1. I enjoyed the FRC Colorado Regional Competition.
2. I was disappointed by the FRC Colorado Regional Competition.
3. If I could participate in more FRC competitions, I would.

Statement 2 was a reverse-coded question to ensure reliability in the study. If the participants genuinely focused their attention on the survey, the results for statement 2 should have been opposite of statement 1. They, in fact, were and reliability for the FRC construct is high. At this point, the responses were then flipped to correlate positively with statement 1.

As previously stated, the FRC construct was most closely correlated to the ColoradoFIRST constructs with a factor of 60.4%. Other variables that indicated a moderate to strong correlation with the FRC construct include:

- Influence on future education (56.5%)
- Influence on teamwork skills (46.8%)
- Influence on career choice (46.1%)

Regression analysis identified attitudes held toward ColoradoFIRST as those that had the greatest impact on attitudes toward the FRC Colorado Regional Competition. In other words, attitudes toward ColoradoFIRST are most responsible for determining the attitudes toward the FRC. Regression analysis is a predictive model, drawing the conclusion that increases in positive attitudes toward ColoradoFIRST will lead to an increase in positive attitudes toward the FRC. This has been quantified as being a factor of .526, or 52.6%.

It is believed that this could be attributed to Social Identity Theory, which posits that individuals will seek to achieve a positive self-concept as both an individual and within any group s/he belongs to. This generally results in a positive attitude toward anything the group does; otherwise, the attitudes toward the group and the attitudes toward the event would be conflicting.

All attitudes toward the FRC were very high regarding race with the exception of African Americans. The average response related to attitudes toward the FRC was 4.33 out of 7 for African Americans. Given that there were only three African American respondents, this is statistically insignificant. It does, however, draw a red flag regarding the involvement of the African American population in ColoradoFIRST and the FRC.

The participants' goals regarding the highest degree they expect to attain also maintained a relationship with attitudes toward FRC. Those wanting to earn Master's or Professional degrees indicated the most positive attitudes toward FRC, followed closely by those wishing to earn Ph.D. Those individuals seeking an Associates or Bachelor's degree recorded less than average, but still very positive, scores. Of the 224 responses, 157 individuals indicated the desire to earn a Master's degree or higher.

Impact on Future Education

To determine attitudes toward both ColoradoFIRST and FRC impact on future education decisions, the participants were asked to indicate the level to which they agreed with the following statements:

1. *FIRST* has helped to prepare me for future education in science, technology, engineering, and/or math.

2. In college, I would like to major in science, technology, engineering, and/or math.
3. *FIRST* has influenced my desire to study science, technology, engineering, and/or math in college.

A fourth statement was presented, however the responses to that statement compromised the reliability of the construct. This means that it was not measuring the same attitudes; it was then removed to ensure that the data were measuring that which was intended.

Colorado*FIRST* influence on future education decisions is most closely correlated to influence on career choice with a correlation factor of 69.7%. This also represents the highest correlation factor of any two attitudinal variables. Other notable correlations existed between attitudes toward Colorado*FIRST* and:

- Influence on future education (56.5%)
- Attitudes toward FRC (47.3%)
- Influence on teamwork (43.9%)

Attitudes toward Colorado*FIRST* influence on future education decisions can be attributed to FRC and Colorado*FIRST*. Colorado*FIRST* has had the greatest influence on future education decisions, followed closely by the FRC competition. This, combined with the FRC results, helps paint the picture that Colorado*FIRST* as an organization is the main factor of influence in helping its participants make future education decisions. In other words, any increase in desire to major in a STEM-related field in college and beyond can be most attributed to what attitude one holds toward Colorado*FIRST* as an organization. This factor has been quantified at a 34.4% influence. FRC followed closely at a factor of 20.2%.

Relationships between Colorado*FIRST* influence on future education decisions and four categorical variables can be noted. These variables are: Race, Intended Major, Degree Goals, and the Number of Years Participating in FRC.

Regarding race, all race categories indicated highly positive attitudes toward Colorado*FIRST* influence with the exception of African Americans. The average response for African Americans was 4.44 out of 7. As stated previously, the sample size for African Americans is too small to be of statistical significance. All other races indicated average response scores of greater than, or equal to, 6.00 out of 7.

Over half of the respondents indicated that they wanted to major in Engineering (97) or Computer Science (32). These individuals showed the highest average attitudes toward Colorado*FIRST* influence on future education decisions at 6.36 and 6.45 out of 7, respectively. Those participants that anticipated majoring in a social science, or

were undecided reported the lowest, but still very positive, attitudes toward the education construct at 5.08 and 5.216 out of 7, respectively.

Those that wish to earn a Master's degree, again, reported the highest positive attitudes toward ColoradoFIRST influence on future education decisions. Once again, this was followed closely by those wanting to earn a Ph.D. with average response scores of 6.37 and 6.18 out of 7.

Finally, the number of years that the respondent participated in FRC held a positive relationship with influence on education decisions. The average attitude increased relative to the number of years of participation in the FRC. All average response scores were greater than 6.00 out of 7. Likewise the number of respondents decreased each additional year of participation. That is to say, there were 112 respondents that had participated in FRC once and there were 20 respondents that indicated they have participated four times.

Influence on Choice of Career

To determine attitudes toward ColoradoFIRST and FRC impact on career choice, the participants were asked to indicate the level to which they agreed with the following statements:

1. *FIRST* has influenced my decision to pursue a career in science, technology, engineering, and/or math related field.
2. I do not want to pursue a career in science, technology, engineering, and/or math.
3. Prior to *FIRST*, I did not know what I wanted to do for a career.

This construct as a whole proved to be unreliable. That is to say that the participants were responding to the statements in an inconsistent manner. Statements 2 and 3 were then dropped due to the fact that statement 1 better suited the intent of the study.

ColoradoFIRST influence on intended career choice was correlated to just two other constructs: Education, and FRC. As previously stated, the correlation factor between career choice and education is quite high at 69.7%, while the factor between career choice and FRC is more moderate at 46.1%.

Regression analysis identified one major factor of influence in determining attitudes toward ColoradoFIRST influence on career choice: ColoradoFIRST influence on future education decisions; this is by a factor of 96.2 %. This means that the attitudes toward ColoradoFIRST influence on career choice can be most attributed to ColoradoFIRST influence on future education decisions. As attitudes toward the influence on

education increase, attitudes toward influence on career choice increase almost equally.

Given ColoradoFIRST influence on future education decisions, it can be surmised that ColoradoFIRST has a great impact on the career path choices made by participants.

Influence on career choice maintained relationships with the same categorical variables as influence on education: Race, Major, Degree Goals, and Years Participating in FRC. These relationships yielded similar results, with the exception that the average scores trended lower. This was most likely due to the increase in standard deviation. Stated simply, the range of responses was much wider, reducing the average response score to a point closer to the mid-point value which is 4.

This would indicate that the choice of career is more a result of other factors. That is ColoradoFIRST influence on studying a STEM-related subject in college and beyond naturally translates into the pursuit of a career in a STEM-related field. This is consistent with the fact that the construct "ColoradoFIRST" as an organization, was not a statistically significant factor in determining attitudes towards career choice. Instead, ColoradoFIRST influence on future education decisions was the main factor.

Ethnicity	Number of Respondents
Caucasian	174
African American	3
Hispanic	18
Native American	1
Asian	23
Gender	
Male	167
Female	62

Underrepresented Students

Students from Hispanic, Native American, and Asian ethnic backgrounds are also satisfied with their experiences; however African American students indicated a much lower, slightly positive, attitude toward their involvement in the FRC Colorado Regional Competition and ColoradoFIRST influence on their desire to pursue an education in a STEM-related field. The mean score for each construct is 4.33 and 4.44 out of 7, respectively.

Regarding FIRST impact on career choice in a STEM-related field, African Americans indicated a negative attitude with a mean score of 3 out of 7.

While these results appear to be highly unfavorable, it should be stated that only three African American participants took the survey. Additionally, for all three significant constructs, responses by African American students had the highest standard

deviation. This indicates that the three participants were highly mixed in their response which most likely means that one of the three students had a negative experience, while the other two had positive and neutral experiences.

Qualitative Research

In an interview with Margy Stevens the director of Ohio's STEM Education Center, she discussed the lack of under-represented students represented in STEM educational programs. In her organization's experience, minority and female students are drawn to "helping fields" such as bio-medical. They are interested in topics under neighborhood revitalization, helping others, and social justice. An area to explore is how to integrate these topics into STEM programs as a way to attract under-represented students.

Suggestions for Future Research

1. More research should be conducted to determine at which point the participants begin to identify with Colorado*FIRST*. Additionally, further research should be conducted to determine if improvements could be made to the FRC competition to draw in more participants that do not currently identify with Colorado*FIRST*. Additional research should include conjoint analysis to determine which components of FRC are most preferable and which have little impact on attitudes. For example, is it the challenge of building the robot or, the competitive nature of FRC or, the sports-related theme or, are all components important.
2. Interview those participants that wish to pursue an education in STEM areas other than engineering and computer programming to determine how to improve the program to meet the needs of a wider range of students interested in STEM-related activities and studies.
3. Interview minority and underrepresented students at schools with a *FIRST* team to identify opportunities to increase involvement and tailor events to their needs.
4. Interviews with various Colorado*FIRST* teams to identify hidden areas of interest that may translate into potential themes for future FRC Competitions.
5. Conduct interviews to gain further insight into Colorado*FIRST* influence on future education choices. Additionally, to determine other factors that play a role in influencing education decisions. This will help to better quantify Colorado*FIRST* influence on education in future surveys.