



Business School

UNIVERSITY OF COLORADO DENVER

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# **Colorado *FIRST FIRST*<sup>®</sup> LEGO<sup>®</sup> League Impact Study**

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**Marketing Dynamics in the 21st Century**

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## Executive Summary

Colorado*FIRST* ([www.coloradofirst.org](http://www.coloradofirst.org)) was founded in 2001 to represent and achieve the mission of *FIRST* ([www.firstinspires.org](http://www.firstinspires.org)), an international 501(c)(3) organization founded in 1989 to inspire K-12 students to actively engage in science, technology, engineering, and math (STEM) through competitive robotics competitions. One of the programs Colorado*FIRST* manages is *FIRST* LEGO League (FLL), where students from grades 4-8 research a real-world problem and are challenged to develop a solution and presenting to a panel of judges. In addition, FLL teams must design, build and program a LEGO Mindstorms® robot to compete on a table-top playing field. The purpose of this impact study is to analyze whether Colorado*FIRST*'s core values are being met in the FLL program.

To conduct this impact study, an online survey was constructed. The survey consisted of 23 questions, tailored to either a parent or mentor of an FLL team. Included in the survey were six different constructs that were designed to help analyze how a young individual is growing and learning from the program. The six constructs included the following:

- Attitude toward encouraging STEM careers
- Impact on social behavior after program participation
- Impact on self-confidence after program participation
- Desire to participate in other *FIRST* programs
- Attitude toward support received by Colorado*FIRST* program
- Overall attitude towards FLL

The survey was distributed via email to all the mentors and parents of the Colorado FLL program. Within a two-week period, 148 survey responses were received, but of the 148, only 122 were completed in full.

The information gathered was analyzed using the Statistical Package for the Social Sciences (SPSS). First, the reliability of each construct was conducted to determine if the question set for each construct was statistically valid for further analysis. Based on our analytical results we found that both parents and mentors are overall satisfied with the FLL program, and the growth that they have seen with their young children. All six constructs saw high satisfaction with average responses ranging from 5.3-6.25 (on a scale 1-7), and the highest number of responses for every construct was a 6 or a 7. Both parents and mentors felt most strongly that their students were more likely to pursue STEM careers after participation in FLL. It was also found that parents felt they had received slightly more support from Colorado*FIRST* than mentors.

Recommendations for Colorado*FIRST* are to continue the path they are on as parents and mentors do feel as if they are seeing improvements in their children's interest in STEM after participating in the FLL program. The core values and goals of Colorado*FIRST* appear to be being met, in the opinions of those surveyed.

## Introduction

In the last few decades discoveries in science and technology have shaped the world that we know today. We have made incredible improvements in computers and cellular devices, huge advances in medicine, and incredible developments in motor vehicles and aviation devices, just to name a few. The need for individuals to pursue careers in science, technology, engineering, and math (STEM) is higher than ever, but unfortunately, we aren't seeing enough young students pursuing these fields to satisfy the need. How can we encourage young students to explore the world of science and technology?

Colorado *FIRST* is a nonprofit organization doing just that. This organization manages *FIRST* programs in Colorado that encourages students of all ages to participate and learn about STEM topics, while also creating fundamental teamwork skills regardless of their future career goals. Our endeavor while working with Colorado *FIRST* was to collect survey information from the parents and mentors of students participating in the Colorado FLL robotics program to analyze whether Colorado *FIRST*'s core values are being met.

## Background Information

According to the U.S. Bureau of Labor and Statistics, "The future of the economy is in STEM. That's where the jobs of tomorrow will be". It is projected that the need for STEM jobs will grow by more than 9 million by 2022, that's 13%, faster than any other field (Vilorio). In 2015, STEM occupations represented 6.2% of U.S. employment, with about 64% of those jobs being found in engineering and computers fields (Watson). As technology becomes a more prominent driving force in our society, the need for individuals to pursue STEM careers will continue to grow. The U.S. is striving to bolster the need for STEM related fields to sustain the innovation enterprise, global competitiveness, and national security. This initiative is in response to the growing concern over low STEM retention rates, a relative decline in STEM graduate school enrollment, and lower STEM graduates compared to other developed countries (Larson).

Colorado *FIRST* was founded in 2001 to help inspire young people's interest in science and technology by managing the programs of *FIRST* in Colorado. Since its inception, Colorado *FIRST* has managed these innovative robotics programs to motivate young people to pursue STEM education and career opportunities, while building self-confidence, knowledge, and life skills. Today there are four *FIRST* programs for ages ranging from 6-18 years of age. Not only do the *FIRST* programs enable kids to learn about science and technology but also key core values such as presentation skills, time management, critical thinking, teamwork, and sportsmanship (*FIRST*).

Based on the trends of STEM education our goal for our survey was to assist Colorado *FIRST* in determining whether, in the eyes of the parents and mentors involved

in the FLL program, the core values were being met. This impact study will be on one of the three programs that are offered through Colorado *FIRST*, *FIRST* LEGO League (FLL). This program is our primary point of study as it is by far the largest of the three programs offered through Colorado *FIRST*. A previous UCD study in 2013 tested similar factors, except with more of an emphasis on why FLL students did not progress on to later *FIRST* programs. This impact study is focused upon the attitude toward the core values, with a small focus on program retention just to test whether the methods implemented from the previous study are working.

The 2013 survey found that parents were satisfied with the program, for the most part felt supported, and felt the core values were being incorporated into their experience. The reasoning found in this previous survey to explain lack of program retention was absence of knowledge of the subsequent programs. In response to this finding Colorado *FIRST* has made more of an effort in educating their FLL teams in other programs offered by *FIRST*.

### Hypothesis Development and Constructs

Within this survey are six constructs to determine whether Colorado *FIRST*'s FLL program was performing its core values to its expected potential by the parents and mentor's standards. We endeavored to measure the attitudes toward these constructs to gauge whether parents/mentors feel that Colorado *FIRST* is still supporting the young learners and their teams, and is fulfilling its intended function as a robotics program. Based on the responses we will be able to give Colorado *FIRST* guidance on whether there are any adjustments that need to be made to the program to satisfy their organizations standards and core values.

The constructs that have been measured during the survey include the following:

Construct	Description	Sample Question
Attitude toward encouraging STEM careers <b>(CAREER)</b>	Measures attitude students might have on STEM careers	My child had an increased interest in STEM after participating in FLL. Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree
Impact on social behavior after program participation <b>(SOCIAL)</b>	Measures effect Colorado <i>FIRST</i> programs have on a student's social behavior	My child was more comfortable communicating with peers and adults after FLL. Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree

Impact on self-confidence after program participation <b>(SELF-CONFIDENCE)</b>	Measures effect Colorado <i>FIRST</i> programs have on a student's self-confidence	FLL has helped your child improve their levels of self-confidence. Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree
Desire to participate in other <i>FIRST</i> programs <b>(PARTICIPATION)</b>	Measures desire to continue with Colorado <i>FIRST</i> and their programs	My child is interested in pursuing further <i>FIRST</i> programs. Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree
Attitude toward support received by Colorado <i>FIRST</i> program <b>(SUPPORT)</b>	Measures attitude towards the mentors and the organization leaders	My child feels as if he/she received adequate support from <i>FIRST</i> . Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree
Overall attitude towards FLL <b>(OVERALL)</b>	Measures overall attitude towards the <i>FIRST</i> LEGO League program	My child participation in the <i>FIRST</i> program has been a positive experience. Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree

These constructs were developed to measure the attitude of the participants based on multiple factors. The constructs were measured on a Likert scale from 1-7, all with 1 being "Strongly Disagree" and 7 being "Strongly Agree".

The reliability of each construct was tested. Reliability refers to whether respondents answered the "same question" that is worded in a different way consistently. A failure of the reliability test can identify inconsistent answers from respondents to a construct and/or issues with the way questions were worded that can impact the ability to rely on the statistical analysis of the construct.

After running the tests, we concluded that the Participation construct is not reliable, yet all other constructs were reliable.

<b>Construct</b>	<b>Alpha</b>	<b>Reliable?</b>
Career	.765	Yes
Social	.843	Yes
Self Confidence	.845	Yes
Participation	.641	No
Support	.701	Yes
Overall	.903	Yes

## **Instrument Design**

Our online questionnaire consisted of 23 questions, directed towards the parents and mentors of the students participating in the FLL program, all who were over the age of 18 years old. Most of the questions were measured on a Likert scale. The questionnaire is based on six different constructs, all focused on measuring the impact that FLL has on the students who participate.

The 23 questions were split into two separate surveys as we were surveying both mentors and parents, who have a different view of the student participants. The first question in our survey was to determine if the survey-taker was a mentor or parent, which would direct them to their specified survey. From there, all six constructs and 23 questions were randomly arranged, all using a Likert scale from 1 (Strongly Disagree) through 7 (Strongly Agree), then five demographic questions at the end of the survey.

All questions were structured utilizing the Dillman Method. Using small words, avoiding repetition of words, increasing clarity, simple and short questions, and lack of complicated jargon. The number of questions was kept to a minimum, with three questions designated per construct and five questions utilized for demographics.

Demographics questions included:

- Mentor/Parent
- Gender
- Occupation
- Level of education
- Number of years participating in FLL

## **Sampling**

A URL for the survey was distributed via email along with a cover letter explaining the purpose and use of this study to all parents and mentors participating in the Colorado *FIRST* FLL Program. The survey was created in Qualtrics, which allowed us to monitor the response rate. Two weeks after the survey was sent out, there were 148 responses, but only 122 were completed fully. A reminder email was not sent. Based on the responses we received, we had about a 12% response rate overall.

## **Methodology**

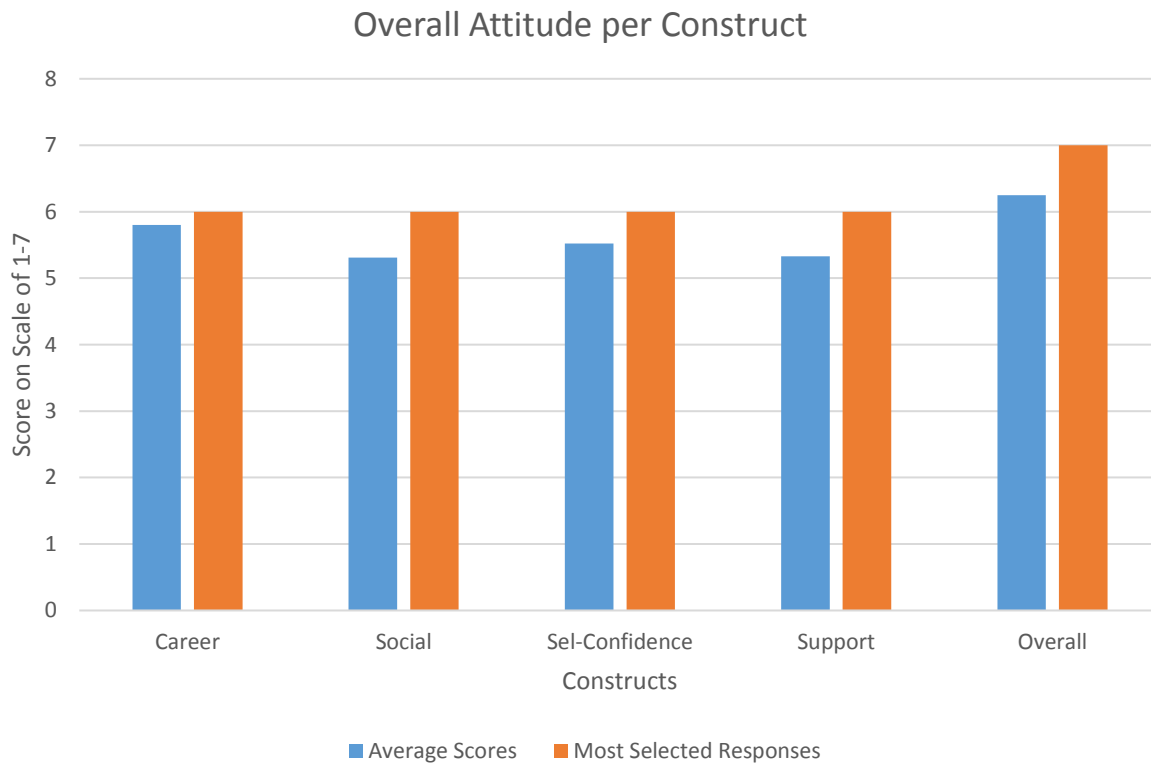
Data was collected using Qualtrics that was easily converted into Excel and SPSS data. Using SPSS, univariate tests were run to determine the average attitudes and most common responses. MANOVA analysis was run to determine how the construct responses differed among parents and mentors. There were no significant results with any of the other demographic variables (ex: gender, years in FLL, etc.). Discriminant Analysis was also run, which produced similar results to MANOVA analysis, but after further analysis we deemed this a poor test and did not use this analysis for results.

## **Results**

When comparing the results of each individual construct, we saw that for every construct most parents and mentors felt that they saw improvement in their students after participation in the FLL Program. The overall attitude toward the FLL program averaged responses of 6.25 (on a scale 1-7), with the highest attitude toward students being encouraged to pursue STEM careers in the future (average score of 5.8).

All constructs scored high in satisfaction, the lowest average score for a construct being 5.31. When analyzing the responses most selected within each construct, most survey-takers selected a 6 out of 7 when considering encouraging STEM careers, their child's social behavior, their child's boosted self-confidence, and the support received by Colorado *FIRST*. The overall attitude of the program was even more favored in both groups, as most selected a score of 7 out of 7 when reflecting on the program overall.

Construct	Average Score (1-7)	Most Selected Response (1-7)
Career	5.80	6
Social	5.31	6
Self Confidence	5.52	6
Participation	5.26	7
Support	5.33	6
Overall	6.25	7

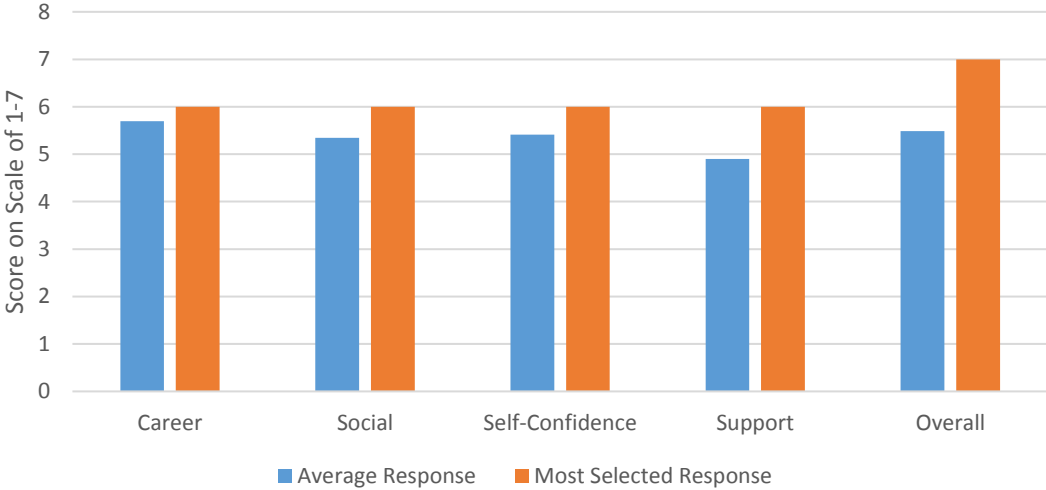




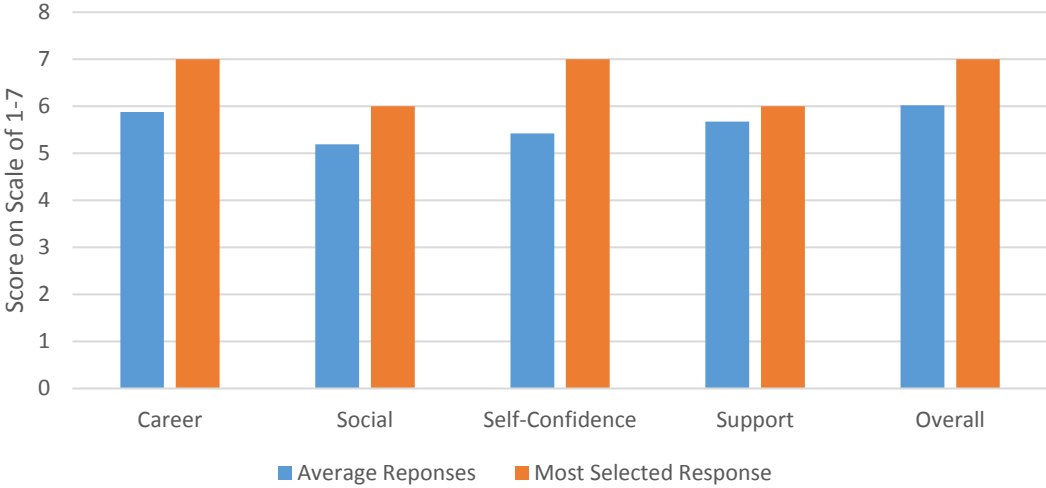
Within the constructs, we found that the overall average attitude toward support received by ColoradoFIRST in completing their challenge was a 5.33. Overall attitude toward support is favorable, yet we found that when this was broken down between parents and mentors we saw that parents felt that they were more supported than mentors did, but only slightly.

Factor	Support Construct Average Response
Mentor	4.901
Parent	5.676

Mentors Attitudes by Construct



Parents Attitudes by Construct



## Discussion

The impact of these results suggests that parents and mentors feel as if their children, students, and community members are benefiting from the Colorado *FIRST* FLL program. They feel as if the core values of the program are being seen in the behavior and interests of the children involved, and are overall satisfied with their participation in the program. This also suggests that more students will potentially be entering STEM career fields when they graduate from high school, which is the overall goal of the *FIRST* program, and many nationwide initiatives. More students entering STEM fields is making our country more competitive in the global marketplace as well as pushing our society toward a higher level of advancement.

When comparing to the previous study conducted with Colorado *FIRST* participants in 2013, we do see some improvement. This earlier study was conducted in response to lack of retention in *FIRST* programs after students get older and can no longer participate in the FLL program. Based on this earlier study, it was found that most students were not continuing past FLL because they simply were unaware that there were programs available. Our survey revealed that most parents and mentors were aware of subsequent programs, and that their students did have interest in participating in those programs when they reached that age level. This indicates that since the previous survey was administered the efforts that Colorado *FIRST* has put forth to educate members about other *FIRST* programs has been successful. We can attest that at the FLL competitions there are live demonstrations and informational booths to educate and garner interest for mentors, parents, and students about later programs.

## Conclusions

In conclusion, *FIRST* LEGO League (FLL) is performing well to meet their standards and core values. Most parents and mentors surveyed were satisfied with the progress their students were making in increased interest in STEM, improved social and teamwork skills, improved presentation and research skills, and support from Colorado *FIRST*. Overall, survey-takers were extremely satisfied with the program overall, would recommend the program to others, and are interested in participating in further FLL programs.

Our recommendations to Colorado *FIRST* are to continue to provide the resources and competitions that they are currently providing. If any additional research is needed, it would be to investigate further into why mentors don't feel as supported as parents. Though these results were expected, we still find the overall satisfaction with support is still high, so this is not an immediate or urgent action needed.

If we were to do this research again there are a few things that we would do differently. First, we would have sent a reminder email to garner more responses. Unfortunately, with this survey, and the placement of a holiday amid our survey time did not permit this. We also could have passed out paper surveys at the FLL

competition we attended to increase the number of responses. Regarding our demographics questions, we would have likely removed some of the more trivial questions such as gender and income, because they didn't really play a part in the results. We would have made an occupation drop-down menu versus a fill in the blank response to obtain more responses for that question, and likely added more demographics questions that were better suited to the overall focus of our study. After participating in the competition of the program, some of our constructs may change for future use surrounding the three major judged competitions within the overall competition. We didn't have many questions regarding the research that went into the presentations, or the teamwork exercise which we thought were very useful life skills that weren't explicitly covered in our survey.

## Citations

"FIRST LEGO League." *FIRST*, 30 Oct. 2017, [www.FIRSTinspires.org/robotics/fll](http://www.FIRSTinspires.org/robotics/fll).

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