Evaluation of the *FIRST*® LEGO® League Explore and *FIRST*® LEGO® League Challenge Class Pack Model

Year 3 Final Report - Executive Summary

Through a series of collaborations over the past eight years, *FIRST*® has partnered with The Research Group at the Lawrence Hall of Science, UC Berkeley to evaluate several of its program models. The present evaluation seeks to understand program implementation and outcomes of the *FIRST*® LEGO® League Explore and *FIRST*® LEGO® League Challenge divisions under the Class Pack model, and are limited to sites that received funding through the LEGO® Foundation's Connections Grant. Our evaluation questions are as follows:

1. What are the outcomes for youth who participate in *FIRST* LEGO League Explore and *FIRST* LEGO League Challenge?
2. Do outcomes differ for those who participate in *FIRST* LEGO League Explore/Challenge in formal education settings (e.g., classroom) vs. informal education settings (after school program)? Do participating youth in formal education settings have similar gains as youth participating in informal settings?
3. What is the impact on educators? Does training provide the skills, knowledge and confidence to facilitate the *FIRST* LEGO League Explore and *FIRST* LEGO League Challenge divisions? How does training relate to youth outcomes? How does training relate to overall program implementation and experience?
4. To what extent do teachers implement *FIRST* LEGO League Explore and *FIRST* LEGO League Challenge Class Pack with fidelity?
5. To what extent are parents aware of, knowledgeable of, and engaged with *FIRST* LEGO League Explore and *FIRST* LEGO League Challenge under the Class Pack model? What strategies are successful in engaging parents, if any?

This Executive Summary presents an overview of findings from Year 3 (2021-2022) of the evaluation. Because Year 2 implementation was impacted by the COVID-19, it was agreed that Year 3 would re-do the implementation study of Year 2, with the modification of the youth and educator instruments and the addition of youth artifacts in lieu of observations. With schools and after-school programs returning to in-person instruction and easing of COVID restrictions, Class Pack implementation was not as impacted by virtual learning (which had limited interactions

between youth, families, and Class Pack educators in Year 2). Thus, in Year 3, we saw an increase in response rates from these groups compared to the previous year. Through these responses, we found that youth and educators had overall positive experiences with the *FIRST* Class Pack program and that sites overall showed higher fidelity across both divisions in Year 3 compared with Year 2. However, educators still made notable adaptations that were not completely aligned with the guidelines provided by *FIRST* and still saw opportunities for improvement – particularly in *FIRST*-provided training and resources. Further details on these findings can be found below and in the full report.

Method

Instruments

Youth Surveys. The youth surveys assessed youth engagement, attitudes, and dispositions toward STEM, as well as holistic skills, such as creativity and problem solving. For STEM attitudes and dispositions, the surveys included questions from the *Emerging STEM Learning Activation Survey* drawn from the *Activation Lab*. Changes in youth activation were measured using a post/retro-pre format, in which youth reflected on their beliefs before and after participating in the program—e.g., how they viewed science before the program and how they viewed science after participating in the program.

Educator Surveys. Educator surveys focused on program implementation (e.g., schedule, characteristics of participating youth, activities engaged in) and gathered the respondent's feedback on the Class Pack Model. These surveys also asked about the impact of the COVID-19 pandemic on implementation.

Educator Interviews. The educator interviews gathered educators' perspectives on their experiences implementing the program, including their perceptions of youths' learning, the value of the programs, and their successes and challenges in leading the program, particularly in light of COVID-19 modifications.

Parent/Caregiver Surveys. The caregiver survey gathered information on parents' awareness of, engagement with, and perceptions of the value of *FIRST* LEGO League Explore and Challenge.

Student Artifacts. Student artifacts were collected to capture implementation and provide evidence of high or low fidelity. Photos and videos of student work included (1) LEGO models, (2) team/group posters, and (3) Engineering Notebooks for *FIRST* LEGO League Explore, and (1) Robot Games, (2) Innovation Projects, and (3) Engineering Notebooks for *FIRST* LEGO League Challenge.

Sample

During the 2021-2022 season, a total of 27 sites were awarded Class Packs and implemented the program. The present evaluation includes data from 16 of the 27 sites implementing the program, including:

- 264 youth surveys (81 Explore; 183 Challenge) from 8 sites (3 Explore only, 2 Challenge only, 3 Both)
- 67 educator surveys (36 Explore; 31 Challenge) from 16 sites (7 sites implementing Explore only, 5 sites implementing Challenge only, 4 sites implementing both)
- 13 educator interviews (8 Explore only; 3 Challenge only; 2 Both) from 11 sites
- 26 caregiver surveys (12 Explore and 14 Challenge) from 4 sites (3 Explore, 1 Challenge)

Key Findings and Recommendations

Key Findings

- **After significant modifications in Year 2, sites showed higher fidelity in Year 3**. Year 2 implementation was mired with significant COVID modifications, with a majority of sites implementing the program in an online or hybrid format, and many working under compressed timelines for implementation. Year 2 educators commonly had to adapt sessions by increasing individual work or removing hands-on components. Year 3 was much closer to "business as usual," with essentially all sites meeting in person and with relaxed COVID restrictions. As such, Year 3 was the first real opportunity to see what *FIRST* LEGO League Explore and Challenge look like under the Class Pack Model.

Figure 1a. Percentage of Sites Completing all 12 Sessions - Explore (n=36)

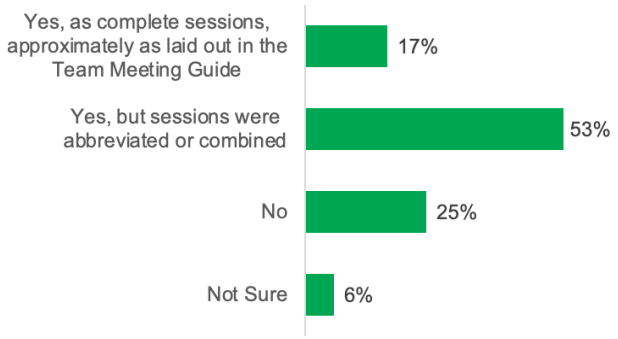
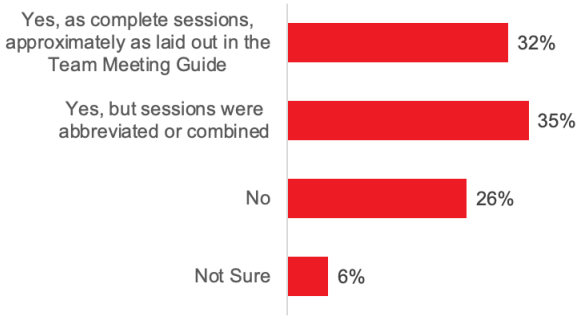


Figure 1b. Percentage of Sites Completing All 12 Sessions - Challenge (n=31)



- **The Class Pack Model positions educators to reach more students, in a variety of contexts, with a wide range of prior experience.** On average, Explore sites served

108 youth and Challenge sites served 37 youth. Explore was nearly equally likely to be implemented during the school day or during an afterschool program, while Challenge was typically implemented during an afterschool program. Youth brought a range of prior experience and STEM interests, and scaffolding to meet these needs could be challenging for educators.

- **Educators made modifications to the program to work within their localized goals, constraints, and context**. Though sites overall showed higher fidelity to the *FIRST* LEGO League program across both divisions in Year 3 compared with Year 2, there were still notable adaptations made that were not completely aligned with the guidelines provided by *FIRST*. A theme that arose from educators' responses was that they felt a need to make adjustments in order to meet the developmental or educational needs of the youth they were working with, including youth who had never used LEGO bricks or programmed before. Common modifications included abbreviating or combining sessions, extending beyond the recommended ages, and reducing the role of the Engineering Notebook.

- **Despite variability in training, educators overall felt prepared to facilitate the program and reported increased confidence in teaching STEM**. The majority of educators participated in some type of training, though just over half participated in *FIRST*-facilitated training. Reflecting on the training, educators overall enjoyed the experience and came away feeling more confident and prepared to facilitate the program; however, there was variability in how confident educators felt in teaching coding and in supporting students with a range of prior knowledge. Regardless of training, educators reported increased confidence in teaching STEM.

  I feel like I had everything I needed. The support was there. I don't remember ever thinking to myself, "Oh, no. I don't know what I'm doing here!" I'm actually – I'm good. I feel really confident about going into this next year and kind of expanding the program in our school. And competing! (Challenge educator)

Table 1a. Changes in Educators' Confidence Teaching STEM - Explore (n=33)

	Much less confident (1)	Slightly less confident (2)	About the same (3)	Slightly more confident (4)	Much more confident (5)	Mean
Teaching about programming/coding	0%	3%	6%	36%	55%	4.42
Using project-based learning to teach STEM	0%	0%	13%	31%	56%	4.44
Making connections between STEM concepts and real-world problems	3%	0%	6%	28%	63%	4.47
Overall mean						**4.44**

Table 1b. Changes in Educators' Confidence Teaching STEM - Challenge (n=29)

	Much less confident (1)	Slightly less confident (2)	About the same (3)	Slightly more confident (4)	Much more confident (5)	Mean
Teaching about robotics	0%	0%	3%	47%	50%	4.47
Teaching about programming/coding	0%	0%	10%	45%	45%	4.35
Using project-based learning to teach STEM	0%	0%	3%	45%	52%	4.48
Making connections between STEM concepts and real-world problems	0%	0%	7%	40%	53%	4.47
Overall mean						**4.44**

- **Educators and parents are interested in more parental engagement, but communication gaps exist.** Parents/caregivers often reported only hearing about *FIRST* LEGO League activities through their youth, and that they were not aware of how they could be more involved. Both educators and parents/caregivers commented that parents felt under-confident in engaging in STEM activities with their youth, and parents expressed a desire for specific activities and materials to use at home with their youth.
- **Expos and Culminating Events are implemented in a variety of ways and are a highly valuable experience for youth.** Educators described wide variation in structure, timing, and audience of culminating events. Despite this variability, educators considered the expo/culminating event a positive and impactful experience for youth. Most commonly, educators across both divisions saw these wrap-up events as settings for youth to share what they have learned with the community, to be celebrated, and to continue practicing teamwork and perseverance.

  In my experience celebrating all the learning students did and being able to look back and their perseverance and drive during an event was very positive. Students also reflected on core values and how they can continue to use these values outside of robotics. (Explore educator)

  It is a way to celebrate what the youth accomplished and to share it with the parents/caregivers. It is a positive way for the youth to learn from their teammates and the other groups around them. (Challenge educator)
- **Youth showed significant increases in STEM Activation and demonstrated improved confidence, teamwork, STEM skills, creativity and problem-solving.** In both Educator and Youth Surveys, youth in both divisions showed significant growth in positive dispositions toward STEM (including STEM Activation, awareness, and interest),

and educators observed improvements in numerous skills related to STEM, teamwork, and creativity/problem solving.

Table 2a. Year 2 and Year 3 Emerging Activation and 21st Century Skill Growth - Explore

	2021 (n=25)			2022 (n=77)		
	Retro-pre mean (SD)[a]	Post mean (SD)	Cohen's *d* [b]	Retro-pre mean (SD)[a]	Post mean (SD)	Cohen's *d* [b]
Emerging Activation	3.14 (0.75)	3.62 (0.42)	0.80*	2.98 (0.62)	3.48 (0.44)	0.78*
21st Century Skills	3.53 (0.74)	3.73 (0.56)	0.27[c]	3.08 (0.99)	3.57 (0.71)	0.57*

* p<0.01, a statistically significant effect;

a. SD = Standard deviation. Higher standard deviations indicate more variability in student scores.
b. Statistician Jacob Cohen provided the following guidelines for interpreting Cohen's d: 0.2 = small effect size, 0.5 = medium effect size, and 0.8 = large effect size (Cohen, 1977).
c. Potentially due to the small sample size, the pre/post change was not statistically significant.

Table 2b. Year 2 and Year 3 Emerging Activation and 21st Century Skill Growth - Challenge

	2021 (n=38)			2022 (n=180)		
	Retro-pre mean (SD)[a]	Post mean (SD)	Cohen's *d* [b]	Retro-pre mean (SD)[a]	Post mean (SD)	Cohen's *d* [b]
Emerging Activation	3.03 (0.37)	3.33 (0.36)	1.33*	2.93 (0.46)	3.27 (0.43)	1.03*
21st Century Skills	2.95 (0.45)	3.28 (0.43)	1.21*	2.78 (0.51)	3.16 (0.48)	0.92*

* p<0.01, a statistically significant effect;

a. SD = Standard deviation. Higher standard deviations indicate more variability in student scores.
b. Statistician Jacob Cohen provided the following guidelines for interpreting Cohen's d: 0.2 = small effect size, 0.5 = medium effect size, and 0.8 = large effect size (Cohen, 1977).

Youth also shared in their own words what they learned. Two examples are below:

> *I learned that you can be an inventor, scientist, you can build things, you can listen to everyone's ideas. Just be you.* (Explore youth participant)

> *Something I learned in FIRST LEGO League Challenge is that you have to believe in yourself and in the process. Sometimes things may not work out the way you planned them to or imagined them to work out but you should still keep trying to look for solutions and not give up.* (Challenge youth participant)

- **Educators had extremely positive perceptions of the programs and reported overwhelmingly positive feedback.** The majority of educators had highly positive experiences, perceived immense value for participating youth, and expressed sincere appreciation for *FIRST*, *FIRST* LEGO League Explore, and *FIRST* LEGO League Challenge. Nearly unanimously, they planned to return next year to facilitate the programs for a new group of students.

  You just see the kids grow. They grow socially, emotionally. They grow academically. This is a full program. I…do FIRST because it's a superior experience.
  (Explore & Challenge educator)

  …Class Pack provides [the idea] that robotics is not just for most students, but for all *students. So every kid can feel that they are worthy to work with [this] equipment.*
  (Explore & Challenge educator)

Recommendations

Based on our findings of Year 3 and the impact of COVID on the original evaluation plan, the evaluation team suggests the following recommendations (elaborated upon in the full report):

1) Continue to emphasize training. Increase availability, accessibility, and flexibility of training options – whether through more times scheduled, recordings, or office hours with program staff.
2) Clarify and emphasize distinctions between different program divisions (Challenge, Explore, or Discover) and implementation models (e.g., Class Pack versus traditional team models), as educators were not always aware of which *FIRST* LEGO League division they were implementing.
3) Provide additional support around programming/coding, particularly for Explore educators.
4) Create and increase resources that can be shared directly with parents/families to increase family involvement.
5) Continue to revisit what is meant by "fidelity." Consider articulating "primary" and "secondary" components of the program to guide educators to implement the program with fidelity. Knowing what is "core" to the program will support educators in making decisions on modifications within their contexts, which many teachers desired. As an intentionally inclusive model, Class Pack needs to be flexible to meet needs, constraints, and goals of different communities.
6) Continue to reflect on key priorities for learning outcomes. Some areas (e.g., math, research skills) are consistently rated lower than others.
7) Pursue additional evaluation studies to better understand youth outcomes through the Class Pack model (i.e., a comparative study of youth outcomes in formal and information education settings and a quasi-experimental study on Class Pack youth participants versus non-participants)

Endnotes

[1]Figures 1a and 1b in this summary correspond to Figures 5a and 5b in the final report.

[2]Tables 1a and 1b correspond to Tables 17a and 17b in the final report.

[3]Tables 2a and 2b correspond to Tables 27a and 27b in the final report.