Evaluation Report for the
2012-2013 California 4-H LM-ROBO Project

Report by Steven Worker on October 24, 2013

Background

Improving youth scientific and engineering literacy poses a continual challenge in the United States as standardized assessments of scientific literacy demonstrate that many young people are below proficient (National Center for Education Statistics, 2011). In addition, a recent National Research Council [NRC] (2009b) report called for a renewed commitment for engineering education in K-12 to fully realize the synergies of a STEM education approach (Science, Technology, Engineering, Mathematics).

Fortunately, a growing body of research has begun demonstrating that out-of-school time (OST) programs help youth learn science (NRC, 2009a; Falk & Dierking, 2010). OST programs emphasizing STEM education can help youth improve their competence, skills, and attitudes around scientific concepts and processes. In addition, these programs promote the holistic growth of young people by embracing a positive youth development approach to building youth assets.

The California 4-H program, administered by the University of California, has renewed its commitment to science and engineering education with the formation of the 4-H Science, Engineering, and Technology (SET) Initiative. In 2012-2013, with funds from Lockheed Martin through the National 4-H Council, California 4-H promoted the formation and growth of educational robotics projects. 4-H *Junk Drawer Robotics* curriculum was designed to promote science and engineering learning through youth design and building using common household objects (Mahacek, Worker, & Mahacek, 2011).

This evaluation report provides a summary of what adults and youth gained from participating in *4-H Junk Drawer Robotics* projects. This report includes data from 56 adults (including a large non-4-H cohort) educators and 29 youth. To provide perspective, throughout California, in the 2012-2013 4-H program year, 357 4-H members and 52 4-H volunteers were enrolled in 4-H robotics projects in 67 of 875 4-H Clubs in 30 of 57 counties. On average, each robotics project had 5 members (median 3) guided by 1 ½ adult volunteers (median 1).

With funding made available by Lockheed Martin through the National 4-H Council, mini-grants were established to specifically assist 9 local programs establish 4-H *Junk Drawer Robotics* projects. Each program received $1,000 to support the implementation of 4-H Junk Drawer Robotics projects. These funds were used to attend training workshops, marketing and promotion, volunteer recruitment and training, as well as materials and supplies.

2012-2013 California 4-H LM-ROBO Sites ***[Recording Observations for Baseline Outcomes]***

1. Merced (met twice a month for 10 months)
2. Sonoma (in afterschool, met once a week for 5 months)
3. Santa Clara (in 4-H club, met once a month for 7 months)
4. Mono (in afterschool, met once a week for 5 months)
5. El Dorado (two projects in 4-H clubs, each met once a month for 5 mo and 8 mo, respectively)

-----

6. Shasta (in charter school, due to staff transitions, project beginning in Fall 2013)
7. Los Angeles (in special interest unit, due to personnel changes, project beginning in Fall 2013)
8. Santa Cruz (in 4-H club, no data collected due to lost contact with project leader)
9. Santa Barbara (in 4-H club, no data collected due to lost contact with project leader)

Training Workshops

Two workshops were offered to help prepare 4-H adult volunteers and teen leaders to facilitate 4-H Junk Drawer Robotics projects; in total 60 people participated in the workshops. The December workshop in San Jose was attended by 37 people assisted by 5 presenters (including Saundra Frerichs, Nebraska). The January workshop in Palmdale was attended by 24 people including a cohort from the Lockheed Martin Leadership Association (LMLA).

Evaluation Methodology

The evaluation design included two primary components (See Table 1). The evaluation was approved by the UC Davis IRB on December 27, 2012. Surveys were collected and data entered into Excel by Emma Davidson, student assistant, and then analyzed by Steven Worker.

Adult/Teen Facilitator Assessment

1. Workshop evaluation (n=56): A survey was administered after each of the workshops (See Appendix 3: Survey for Project Leaders PRE-TEST).
2. Post-Project (n=8): Facilitators were asked to complete a survey after the conclusion of their projects (See Appendix 4: Survey for Project Leaders POST-TEST).

Youth Assessment

3. Pre (n=23) & Post (n=29) Tests: The pre-tests were administered at selected sites before youth began participating in the project while the post-tests were administered after youth completed their participation in the project. The instruments are available in Appendix 1: Draw-a-Robot Test & Open-Ended Questions; and Appendix 2: Science & Engineering Survey.

Table 1.
2012-2013 LM-ROBO Desired Results and Associated Assessment Instrument.

Desired Result	Assessed	Instrument	Instrument Source
For adult facilitators: Improve the confidence and competence of adult 4-H volunteers in delivering engineering education.	Workshop evaluation (n=56) (Appendix 3) Post-Project (n=8) (Appendix 4)	8-open-ended questions. Retrospective survey Q1-18	Adapted open-ended questions from CYFAR and TechXcite adult surveys. Borrowed 17 questions from the survey used with the 4-H SET Winter workshops 2011.
For youth: Improve young people's interest in and improved attitude for science and engineering.	Pre (n=23) Post (n=29)	Part A: 7-open-ended questions	A few of these questions were used by Nebraska in the outcome evaluation testing of the 4-H Robotics curriculum (Grandgenett, 2010). The others were created to assess perception of differences between science and engineering, application (used in real life and in your life), and career awareness.
		Part B: 4-H Robotics Youth Survey ▪ 4-H Science Common Measure Q1-25 ▪ 4-H Engineering measure Q26-42	25 questions from the California 4-H Science Common Measure. Added 17 questions specific to "engineering": combo of replacing "science" with "engineering" and asking about abilities from the 4-H engineering cycle.

Findings

Adult/Teen Facilitator Assessment Results

This section includes data from the facilitator assessments including the pre-project (workshop evaluation) and the post-project survey.

1) Workshop evaluation (n=56)

The December 2012 workshop (n=33) was attended by 1 staff, 24 adult volunteers, and 7 teens; 19 female and 13 male. The January 2013 workshop (n=23) was attended by 1 staff, 8 adult volunteers, 3 teens, and 10 Lockheed Martin employees; 8 female and 15 male. Most participants did not have previous experience with the 4-H Junk Drawer Robotics curriculum though five had participated in a workshop previously (presumably in 2010 or 2011) and nine had led Junk Drawer Robotics activities or projects in previous years.

Satisfaction. Overall, most participants were satisfied with the workshop and responded either "Agree" or "Strongly Agree" that "I was satisfied with today's workshop" (mean[1]=4.63, SD=0.70). There was not any statistically significant difference in the means between the December (4.58) and January (4.70) workshops.

Abilities. Overall, most participants indicated that the workshop helped improve their abilities by responding with "Mostly" or "Absolutely" that "Did this workshop enhance your abilities as an educator?" (mean[2]=4.48, SD=0.74). There was not any statistically significant difference in the means between the December (4.45) and January (4.52) workshops.

Participants were asked to self-assess 18 specific abilities (See Table 2) and then retrospectively assess their abilities prior to the workshop. Retrospective post-test methodology may help reduce "response-shift bias" where when using a traditional pre/post-test method participants overestimate responses on a pre-test and underestimate responses on the post-test (Raidl et al., 2004).

For all 18 questions, there was a statistically significant difference between the paired items (calculated using a paired t-test, with $p<0.0014$ for all items).

Highest means[1]. The items with the largest post-means included Q1 (4.39) "I understand how to use open-ended questions for inquiry-based teaching, such as 'What do you know about robots?'"; Q2 (4.23) "I understand how to encourage youth to investigate their own questions and ideas"; and Q3 (4.20) "I understand how to encourage youth to explore questions and ideas derived from their own experiences".

Greatest overall increase. The items with the largest increase in the mean from retrospective-pre to post were Q2 (increase of 0.46) "I understand how to encourage youth to investigate their own questions and ideas"; Q8 (increase of 0.59) "I understand how to act as a facilitator for youth as they work on their activities"; Q14 (increase of 0.53) "I understand how to begin activities with broad, open-ended questions that are focused on the concept(s) of the activity"; Q15 (increase of 0.48) "I understand how to help youth develop communication skills to report data and observations"; and Q18 (increase of 0.43) "I understand how to help youth use the engineering design process to solve a problem".

Most prepared. Participants were invited to respond to the prompt, "As a result of todays' workshop, in what topic do you feel most prepared?" Responses were coded with one word that best represented their text, no pre-existing coding scheme was used, and responses containing more than one concept were coded for each.

- Curriculum (5) and specific activities (15): Some responded that they felt prepared in the curriculum overall, and specific activities they had completed during the workshop; e.g., the December workshop focused on activities from Level 2 (gears, circuits) while the January workshop used activities from Level 1 (catapults, hydraulics).
- Facilitation (14) and inquiry-approach (3) – this included comments such as "helping young kids learn and discover" and "how to keep the workshops open ended"
- Positive youth development (2) - "applying robotics to meet 4-H concepts of belonging, mastery, independence, and generosity"
- Materials used in the curriculum (2)

[1] Likert responses converted to 1=Strongly Disagree, 2=Disagree, 3=Neither Agree Nor Disagree, 4=Agree, 5=Strongly Agree
[2] Likert responses converted to 1=Not at all, 2=A little, 3=Somewhat, 4=Mostly, 5=Absolutely

- And one of each: engineering design, networking with colleagues, youth notebook, competence, and confidence

Additional training needs. Participants responded to the prompt, "In what area do you feel you need additional preparation"?" Responses were coded in an open-coding phase, with most responses containing one concept and a few containing more than one.

- Need more experience (6) - "I need to practice with the kids, then I will most likely have more questions"
- Need information on the curriculum (5), particularly Levels 2 and 3 (specifically shared by those in the January workshop).
- More background on concepts; e.g., circuits and electronics (5), gears (4), hydraulics (3), mechatronics (1)
- Information on adapting the curriculum to younger audiences (3)
- More practice and information on facilitation (3) – "ways to tell people what to do without actually telling them" and "how to give direction without lecturing."
- And one of each: engineering design, project logistics, finding materials, and using the youth notebook.

2) Post-project survey (n=8)

From the nine sites, post-project adult surveys were returned from 5 of the sites (Merced=2, Mono=2, Santa Clara=1, El Dorado=2, and Sonoma=1). Challenges were uncounted from 4 sites and no data were collected.

Abilities. Participants were asked to self-assess 18 specific abilities (See Table 2) and then retrospectively assess their abilities prior to starting the project. For all 18 questions, there was <u>not</u> a statistically significant difference between the paired items (calculated using a paired t-test). There was also no significance between the "now" (sub A questions) questions on the workshop evaluation survey and the post-project survey.

Highest means[1]. The items with the largest post-means included Q2 (4.38) "I understand how to encourage youth to investigate their own questions and ideas."; Q8 (4.38) "I understand how to act as a facilitator for youth as they work on their activities"; and Q16 (4.38) "I understand how to teach youth using techniques other than lectures or demonstrations."

Greatest overall increase. The items with the largest increase in the mean from retrospective-pre to post were Q2 (increase of 0.88) "I understand how to encourage youth to investigate their own questions and ideas; Q3 (increase of 0.88) "I understand how to encourage youth to explore questions and ideas derived from their own experiences; and Q4 (increase of 1.00) "I understand how to encourage youth to use science and engineering terms and concepts."

Seven open-ended comments. Participants were invited to respond to open-ended comments about their experience facilitating 4-H Junk Drawer Robotics projects.

What worked well. Participants responded that the open-ended and hands-on nature of activities worked well in allowing youth to be creative. One adult facilitator said that having the supplies provided and not having to obtain them personally was helpful.

What did not work well. Each project appeared to experience their own limitations. In one group, some of the activities did not work well that required 4-6 people as their group was smaller. In another group, the project leader worried whether they would have enough supplies. A few groups experienced challenges in providing guidance on the activities and concepts and the need to do additional research. The youth notebook seemed to be an issue in many groups, specifically that the youth found them boring or 'like school'.

Adjustments to the curriculum. Most of the projects reported adapting and changing the curriculum. Modifications I included combining two activities into one, changing explanations, modifying timing (shorter or longer, depending on the situation), adding activities, and using different materials and supplies than were specified in the curriculum. These adjustments were made depending on the level and ability of the group and/or individuals, to keep youth engaged in the project (e.g., "rowdy bunch", desire to "build things that moved"), due to school availability (e.g., STAR testing).

Youth recruitment. Projects used a variety of strategies to recruit youth, including the county 4-H newsletter, flyers in schools, and a county-wide email to members who had participated previously or had shown an interest.

What facilitators thought youth liked. By and far, facilitators reported that they believed youth liked the "hands-on experience" and "building" parts, but not so much the "designing" component (i.e., having to design on paper before interacting with the materials).

What facilitators thought youth disliked. Two themes emerged from participants' responses: a) youth tended to dislike lecturing, or as one responded put it "where there was a lot of education caused youth to be rowdy"; and b) the designing component where youth had to draw a design before they could start building. One facilitator captured this when he/she said "We did not use the workbooks. Students were in school all day and would not be interested in any more writing."

Overall comments. In the "other comments" box, three responses were received:

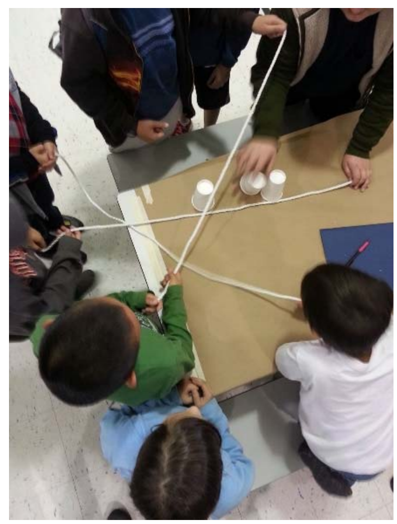
"It is a great curriculum. The lessons that were short on education and long on building was the best part. I find that the designing and planning is best done in steps with education."

"I highly recommend this program. It helps youth think out of the boy while learning engineering principles that can be applied to other platforms (virtual, lego)."

"I think the robotics programs is an amazing opportunity for engineer-minded youth. 4-H has offered access to programs where certain students would have been excluded due to cost constraints. 4-H is affordable and provides access to all students."

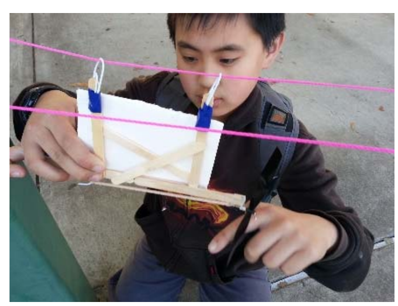
Vignette from the Sonoma County Adult Facilitator

The school has an on-site volunteer recruiting for after school events. She was able to fill the 15 available slots for the program within a week. Kids generally came to our program right after school, at 3 PM, and were a bit tired from the day though energized to start building. They did not like any task which required a lot of reading and any type of quiz or writing task prior to building their projects. Interactive hands-on projects worked well. For example, in talking about how robots think and sense, we had pairs of kids try to pick up a paper cup using only a taught piece of string. They soon figured out that they need 2-3 pairs of kids with one person taking command of the activity. It was a good lesson into how robots need to parse out task control thinking step by step.



I basically pared down the JDR curriculum levels 1, 2, and 3 and took bits and pieces of it to form an entirely new curriculum. My curriculum is based on the fact that we would only meet 4-6 times, two hours per meeting and each meeting was to be an independent project not based on the previous one. That way kids could miss a meeting or two, and still be able to fully participate in the meeting they did attend. I put a lot of time into researching the projects, materials, and building process and each project was really different. Many kids were exposed to some tools and building procedures for the first time. For example, kids needed to learn to strip wire, crimp connections to wire, fasten connections to a board and test the wiring using a voltmeter. All of these tools and techniques were new to many of the kids.

We had several boys in our group that were quite rambunctious, very short attention span though quite talented at building. I had designed each meeting to have a "problem" to be "solved" by an invention or build. Then summarized by a "test" to see if the problem was solved. Most meetings were finished on time, but just barely. A better approach may have been to provide fewer projects, then spend more time refining the "build" and "test" portions, so that the kids would not be so rushed.



The kids we had in our after school program loved it. Parents would say that the kids only talked about what they learned, could not wait for the next activity and kept all their completed activities on their desks. Carefully doing each activity at home, in advance, with an adult and a couple kids helped cement the ideas. Since each activity was completely different, it required some careful research to make sure we had the correct parts and building procedures were not too difficult and could be completed in the two hour allotment. Having 2-3 adult volunteers at each meeting was essential. They could wrangle kids whose attention span waned and helped them to complete their projects.

Thoughts for the future. I think this is a great program. I would like to see 4-H do several things with it. First, make a new set of "fast track" curricula projects that could be done in 1-3 hours. Make these curricula stand alone, but also linkable to a greater project goal. For example, I had thought of doing a set of projects to build a low cost, Arduino wheeled robot that would take 10-12 hours to complete. However, in testing, I quickly found out that it was difficult for kids to not have something to show and play with , and it was also difficult for them to remember to bring in parts from previous meetings. Second, I would like to see the JDR become a fixture at the county and state 4-H fairs. My feeling is that the 4-H fairs are still heavily weighed on livestock, small animal and craft projects and with very few awards and ribbons for technology projects. Having more categories in local, county, and state fairs for SET would encourage more kids to participate in 4-H and SET in the summer "off" period, where many other 4-H kids are showing their animals and crafts. Last, I would like to see JDR integrated into a National Youth Science Day activity. I think JDR is perfectly suited for such an event.

Table 2.
Facilitator Survey Results.

Question[1]	PRE-Project				POST-Project			
	N	Mean[2]	Std Dev.	T-Test	N	Mean[2]	Std Dev.	T-Test
1a. I understand how to use open-ended questions for inquiry-based teaching, such as "What do you know about robots?	56	4.39	0.49	Significant difference ($p<0.0001$)	8	4.25	0.89	Not significant ($p<0.250$)
1b. [*Before participating in this workshop*]/ [*Before facilitating the 4-H Junk Drawer Robotics curriculum*] I understood how to use open-ended questions for inquiry-based teaching, such as "What do you know about robots?	56	3.93	0.71		8	3.63	1.30	
2a. I understand how to encourage youth to investigate their own questions and ideas.	56	4.23	0.47	Significant difference ($p<0.001$)	8	4.38	0.74	Not significant ($p<0.133$)
2b. [*Before participating in this workshop*]/ [*Before facilitating the 4-H Junk Drawer Robotics curriculum*] I understood how to encourage youth to investigate their own questions and ideas.	56	3.89	0.78		8	3.50	1.20	
3a. I understand how to encourage youth to explore questions and ideas derived from their own experiences.	56	4.20	0.52	Significant difference ($p<0.001$)	8	4.25	0.71	Not significant ($p<0.133$)
3b. [*Before participating in this workshop*]/ [*Before facilitating the 4-H Junk Drawer Robotics curriculum*] I understood how to encourage youth to explore questions and ideas derived from their own experiences.	55	3.82	0.72		8	3.38	1.06	
4a. I understand how to encourage youth to use science and engineering terms and concepts.	56	3.88	0.72	Significant difference ($p<0.0011$)	8	4.00	0.53	Not significant ($p<0.104$)
4b. [*Before participating in this workshop*]/ [*Before facilitating the 4-H Junk Drawer Robotics curriculum*] I understood how to encourage youth to use science and engineering terms and concepts.	56	3.52	0.79		8	3.00	1.20	
5a. I understand how to ask youth to explain their thinking.	56	4.11	0.53	Significant difference ($p<0.0014$)	8	3.75	1.04	Not significant ($p<0.197$)
5b. [*Before participating in this workshop*]/ [*Before facilitating the 4-H Junk Drawer Robotics curriculum*] I understood how to ask youth to explain their thinking.	56	3.75	0.74		8	3.00	1.31	
6a. I understand how to help youth discuss the concepts of a lesson after completion of an activity.	56	4.11	0.71	Significant difference ($p<0.0013$)	8	4.00	0.93	Not significant ($p<0.197$)
6b. [*Before participating in this workshop*]/ [*Before facilitating the 4-H Junk Drawer Robotics curriculum*] I understood how to help youth discuss the concepts of a lesson after completion of an activity.	56	3.71	0.82		8	3.25	1.16	
7a. I understand how to ask probing questions to redirect youths' investigations.	56	4.04	0.69	Significant difference	8	4.13	0.99	Not significant

Question[1]	PRE-Project				POST-Project			
	N	Mean[2]	Std Dev.	T-Test	N	Mean[2]	Std Dev.	T-Test
7b. *[Before participating in this workshop]/ [Before facilitating the 4-H Junk Drawer Robotics curriculum]* I understood how to ask probing questions to redirect youths' investigations.	56	3.66	0.84	(*p*<0.0012)	8	3.38	1.30	(*p*<0.197)
8a. I understand how to act as a facilitator for youth as they work on their activities.	56	4.21	0.59	Significant difference (*p*<0.0001)	8	4.38	0.74	Not significant (*p*<0.197)
8b. *[Before participating in this workshop]/ [Before facilitating the 4-H Junk Drawer Robotics curriculum]* I understood how to act as a facilitator for youth as they worked on their activities.	56	3.63	0.82		8	3.63	1.30	
9a. I understand how to help youth develop observation skills in order to collect good scientific data.	56	3.95	0.67	Significant difference (*p*<0.0010)	8	3.75	0.89	Not significant (*p*<0.250)
9b. *[Before participating in this workshop]/ [Before facilitating the 4-H Junk Drawer Robotics curriculum]* I understood how to help youth develop observation skills in order to collect good scientific data.	56	3.63	0.78		8	3.13	1.13	
10a. I understand how to encourage youth to apply skills in new situations.	55	4.098	0.52	Significant difference (*p*<0.001)	8	3.88	0.64	Not significant (*p*<0.381)
10b. *[Before participating in this workshop]/ [Before facilitating the 4-H Junk Drawer Robotics curriculum]* I understood how to encourage youth to apply skills in new situations.	54	3.76	0.73		8	3.38	1.06	
11a. I understand how to create opportunities for youth to work together without direct instruction from me.	55	3.87	0.86	Significant difference (*p*<0.001)	8	3.75	0.89	Not significant (*p*<0.279)
11b. *[Before participating in this workshop]/ [Before facilitating the 4-H Junk Drawer Robotics curriculum]* I understood how to create opportunities for youth to work together without direct instruction from me.	55	3.51	0.84		8	3.13	0.99	
12a. I understand how to encourage youth to use scientific knowledge to form a question.	55	3.87	0.72	Significant difference (*p*<0.0001)	8	4.00	0.53	Not significant (*p*<0.197)
12b. *[Before participating in this workshop]/ [Before facilitating the 4-H Junk Drawer Robotics curriculum]* I understood how to encourage youth to use 55scientific knowledge to form a question.	55	3.55	0.79		8	3.25	1.16	
13a. I understand how to encourage youth to apply concepts they learn to new situations.	55	4.09	0.62	Significant difference (*p*<0.0001)	8	4.00	0.53	Not significant (*p*<0.133)
13b. *[Before participating in this workshop]/ [Before facilitating the 4-H Junk Drawer Robotics curriculum]* I understood how to encourage youth to apply concepts they learn to new situations.	54	3.72	0.71		8	3.13	1.13	

Question[1]	PRE-Project				POST-Project			
	N	Mean[2]	Std Dev.	T-Test	N	Mean[2]	Std Dev.	T-Test
14a. I understand how to begin activities with broad, open-ended questions that are focused on the concept(s) of the activity.	55	4.04	0.69	Significant difference (p<0.0001)	8	4.13	0.64	Not significant (p<0.197)
14b. [*Before participating in this workshop*]/[*Before facilitating the 4-H Junk Drawer Robotics curriculum*] I understood how to begin activities with broad, open-ended questions that are focused on the concept(s) of the activity.	55	3.51	0.81		8	3.38	1.06	
15a. I understand how to help youth develop communication skills to report data and observations.	54	4.06	0.76	Significant difference (p<0.0001)	8	3.88	0.64	Not significant (p<0.180)
15b. [*Before participating in this workshop*]/[*Before facilitating the 4-H Junk Drawer Robotics curriculum*] I understood how to help youth develop communication skills to report data and observations.	54	3.57	0.92		8	3.25	1.28	
16a. I understand how to teach youth using techniques **<u>other</u>** than lectures or demonstrations.	53	4.09	0.74	Significant difference (p<0.0014)	8	4.38	0.74	Not significant (p<0.227)
16b. [*Before participating in this workshop*]/[*Before facilitating the 4-H Junk Drawer Robotics curriculum*] I understood how to teach youth using techniques **<u>other</u>** than lectures or demonstrations.	53	3.72	0.86		8	3.88	1.36	
17a. I understand how to encourage youth to use the results of their investigations to answer their own questions.	53	4.13	0.62	Significant difference (p<0.001)	8	4.00	0.53	Not significant (p<0.180)
17b. [*Before participating in this workshop*]/[*Before facilitating the 4-H Junk Drawer Robotics curriculum*] I understood how to ask encourage youth to use the results of their investigations to answer their own questions.	53	3.79	0.77		8	3.38	1.06	
18a. I understand how to help youth use the engineering design process to solve a problem.	53	3.92	0.76	Significant difference (p<0.001)	8	3.63	0.74	Not significant (p<0.265)
18b. [*Before participating in this workshop*]/[*Before facilitating the 4-H Junk Drawer Robotics curriculum*] I understood how to help youth use the engineering design process to solve a problem.	53	3.49	0.89		8	2.88	1.25	

[1] In the pre-project survey the retrospective item (b) reads "Before participating in this workshop" while in the post-project survey the retrospective item (b) reads "Before facilitating the 4-H Junk Drawer Robotics curriculum"
[2] Likert response options converted to 1=Strongly Disagree, 2=Disagree, 3=Neither Agree Nor Disagree, 4=Agree, 5=Strongly Agree

3) Youth Assessment Pre (n=23) & Post (n=29)

This section includes data from the youth assessments.

Part A: Eight Open-Ended Questions, Pre (n=9), Post (n=19)

The questions were intended to probe deeper into young people's understanding and conceptions of science, engineering, and robotics. While these questions were intended to be administered pre and post, in most cases, sites were unable to collect the pre data, so given the low response rates, only post-project data is reported. Responses were coded with one word that best represented their text, no pre-existing coding scheme was used, and responses containing more than one concept were coded for each.

What does a scientist do? What does an engineer do? (n=18). These two questions elicited different themes of responses with scientists being seen as those who study and experiment while engineers were seen as designers and builders. The words used to describe scientists included study (6), experiment (3), think (3), research (2), and one response each for theories, prove, discovers, figure out, find answers, and test. The words used to describe engineers included build (7), design (5), make (4), communicate (3), fix (2), and create (1). One cluster of responses from the Santa Clara site for engineers was around communicating and talking through drawing, which may indicate that this site stressed a drawing and designing aspect of engineering. Example responses included "communicate through words and drawing" and "talk using description, drawing, and words".

What is the engineering design process? (n=18). Two themes emerged, the first being that engineering design is a process consisting of multiple parts or steps. Responses included things like "problem, ideas, draw, build, test" or "design, build, test", or a copy of the six-step process included in the curriculum itself. The second theme was that engineering emphasizes drawing on paper. Many respondents emphasized that the design process is "having an idea and putting it on paper" or "drawing what you're going to build on paper."

What is a robot? Most youth responded with a definition that included two primary components, first that of a "machine", "computer", or "object" that "helps people", "can do something", or "moves for a purpose."

How are robots used in real life? In analyzing responses, there appeared to be three general categories of responses ranging from broad concepts, to application, to specific. Those who responded with a broad view (8) talked about things including "exploring", "for testing things" and "to help people with their jobs". Those providing an application (6) response included such things as "cranes, computers", "in factories for packing", "manufacturing". Specific examples (4) included "as a rumba", "paint a car", and "used in disabling IED."

What jobs and careers use robots? Most youth provided examples of careers, including "automobile makers", "building, construction, road repair, creating cars and vehicles, packaging, and fixing cars", though a few responded more broadly with "engineers and scientists" and one youth responded "almost all jobs and careers."

How could you use a robot in your life? The emerging theme for this question was using robots to help with homework and household chores. One respondent added "automatic chicken coop door opener" and another with "computers are robots and people use them everyday."

Figure 1.
List three words that come to mind when you think of a robot.
The list of words were inputted into wordle.net and the result is this world cloud.

Part B: Youth Science and Engineering Survey, Pre (n=15), Post (n=21)

The youth survey was administered by adult 4-H volunteers at their respective sites before the project began and then again after the project ended. The instrument contained 42 questions with the first 25 items from the California 4-H Science Common Measure (19 from the National 4-H Science Common Measure) and the remaining 17 questions adapted for engineering (in many cases the word "engineering" was substituted for the word "science"). The instrument was divided into six scales:

1. Science Attitudes and Interest Scale (Q1-13), mostly 4 point[3] but some 5 point[4] response options
2. Scientific Practices Scale (Q14-18, 5 questions), all 4 point[5] response options
3. Project-in-Action Scale (Q19-21), 5 point[4] response options
4. Application of Learning Scale (Q22-26), Yes/No dichotomous
5. Engineering Attitudes and Interest Scale (Q27-36), 5 point[4] response options
6. Engineering Practices Scale (Q37-42, 6 questions), 4 point[5] response options

Responses had to be standardized due to the varying response options present on the instrument and desire to compare scores across questions. To accomplish this, the Percent of Maximum Possible (POMP) Scores technique was calculated according to Milfont (2010).

The number of respondents, along with the standardized means and standard deviations, for the pre and post table are presented in Table 3. Approximately two-thirds of the post-test means for each question are higher than their respective pre-test mean. However, paired t-test comparisons of the pre-test means to the post-test means demonstrated no statistically significant relationships. It may be likely that the lack of statistical significance was due to the low sample size rather than there not being any improvement of participant's science and engineering attitudes or their practices from pre to post.

In general, youth reported more favorably (e.g., "Agree" and "Strongly Agree") to the science and engineering interest and attitude questions than the science and engineering practices questions. To explore this, composite variables were created for four scales (#1, 2, 5, and 6 above) by summing the respective responses for each question (post-data only; pre-data was not included due to the low sample size). In general, the alpha scores indicated a high degree of internal consistency reliability of the scales. The composite variables were standardized using POMP due to the unequal number of questions for each scale and the varying response options. Table 4 provides the scale means and standard deviations. Both the science interest and engineering interest means were approximately equivalent, but the engineering practices scale mean (61.70) was much higher than the science practices scale mean (43.33). A paired t-test revealed a statistically significant difference between these means ($t=4.99$; $p<.001$) which would indicate that youth rated themselves as more confident in their abilities to engage in the practices of engineering (e.g., identifying problems, generating ideas, evaluating solutions, etc.) than engaging in scientific practices (e.g., forming questions, designing a procedure, using data, using science terms, etc.).

[3] 4-point Likert: 1=Strongly Disagree, 2=Disagree, 3=Agree, 4=Strongly Agree
[4] 5-point Likert: 1=Strongly Disagree, 2=Disagree, 3=Neither Agree Nor Disagree, 4=Agree, 5=Strongly Agree
[5] 4-Point Likert: 1=Never, 2=Sometimes, 3=Usually, 4=Always

Table 3. Youth Survey Data Pre and Post (reported as standardized POMP scores).

Scale	Question	PRE-Test			POST-Test		
		N	Mean	SD	N	Mean	SD
Science Interest and Attitudes Pre α=0.858 Post α=0.904	1. I like science	11	75.76	30.15	22	83.33	17.06
	2. I am good at science	11	72.73	20.10	22	72.73	16.70
	3. I would like to have a job related to science in the future	11	51.52	31.14	22	63.64	28.93
	4. I do science-related activities that are not for schoolwork	11	42.42	26.21	22	72.73	22.15
	5. I think science will be important in my future	11	78.79	16.82	21	73.02	24.99
	6. Science is useful for solving everyday problems	11	72.73	25.03	21	77.78	24.34
	7. Science is one of my favorite subjects	10	70.00	24.60	21	76.19	18.69
	8. I like to see how things are made or invented	11	84.85	17.41	21	80.95	19.92
	9. I like experimenting and testing ideas	11	78.79	22.47	21	77.78	21.94
	10. I get excited about new discoveries	11	78.79	22.47	21	87.30	22.30
	11. I want to learn more about science	11	72.73	29.13	21	79.37	19.65
	12. I like to watch television programs about science	11	61.36	17.19	21	57.14	30.76
	13. I like to talk about science with my friends	11	54.55	18.77	20	43.75	34.29
Scientific Practices Pre α=0.881 Post α=0.894	14. I can use scientific data to form a question	11	48.48	17.41	21	57.14	33.57
	15. I can design a scientific procedure to answer a question	11	45.45	22.47	21	46.03	32.45
	16. I can use data to create a graph for presentation to others	11	45.45	26.97	21	65.08	30.69
	17. I can create a display to communicate my data and observations	11	45.45	30.81	21	61.90	28.45
	18. I can use science terms to share my results	10	53.33	23.31	21	58.73	27.70
4-H Learning Environment Pre α=0.916 Post α=0.887	19. In my 4-H projects, I get to do hands-on activities	9	63.89	30.90	19	80.26	28.36
	20. In my 4-H projects, I am encouraged to ask questions	8	71.88	16.02	19	71.05	29.18
	21. In my 4-H projects, I get to plan and carry out investigations	8	65.63	18.60	19	73.68	26.97
Application of Learning Pre α=0.278 Post α=0.489	22. In my 4-H projects, I have helped with a community service project that relates to science *(for example: planted trees or garden, road or stream clean-up, recycling)*	7	85.71	37.80	18	94.44	23.57
	23. In my 4-H projects, I used science tools to help in the community *(for example: mapped with GIS, tested water quality)*	7	42.86	53.45	18	27.78	46.09
	24. In my 4-H projects, I taught others about science *(for example: demonstrated, gave presentation, led a project)*	7	28.57	48.80	18	50.00	51.45
	25. In my 4-H projects, I organized or led science-related events *(for example: science fair, environmental festival)*	7	28.57	48.80	18	27.78	46.09
Engineering Interest and Attitudes Pre α=0.918 Post α=0.948	26. I like engineering	8	81.25	17.68	21	77.38	22.23
	27. I am good at engineering	8	68.75	22.16	21	70.24	26.95
	28. I would like to have a job related to engineering in the future	8	68.75	22.16	21	64.29	29.12
	29. I do engineering-related activities that are not for schoolwork	8	62.50	23.15	21	60.71	34.97
	30. I think engineering will be important in my future	8	84.38	18.60	20	73.75	24.97
	31. Engineering is useful for solving everyday problems	7	78.57	22.49	19	81.58	20.14
	32. Engineering is one of my favorite subjects	8	65.63	18.60	19	69.74	25.79
	33. I like to build and construct things	8	93.75	11.57	19	85.53	19.21
	34. I want to learn more about engineering	8	78.13	20.86	19	77.63	21.88
	35. I like to watch television programs about engineering	8	53.13	16.02	19	57.89	34.41
	36. I like to talk about engineering with my friends	8	46.88	20.86	18	52.78	31.96
Engineering Practices Pre α=0.545 Post α=0.954	37. I can identify engineering problems	8	45.83	17.25	19	54.39	33.72
	38. I can generate ideas and possible solutions	8	62.50	21.36	19	63.16	29.18
	39. I can evaluate and compare possible solutions	8	58.33	23.57	19	64.91	30.38
	40. I can select a solution, develop and refine the design selected	8	62.50	11.79	19	61.40	25.49
	41. I can evaluate or test the design	8	58.33	15.43	19	64.91	26.00
	42. I can communicate the final product	8	58.33	23.57	19	61.40	25.49

Table 4. Youth Survey Data (post-only) for 4 Scales (reported as standardized POMP scores)

	N	Mean	SD	Paired T-Test
Science Interest	20	71.83	17.26	No significant difference.
Engineering Interest	18	72.60	20.06	
Science Practice	21	43.33	19.26	Statistically significant difference ($t=4.99$; $p<.001$)
Engineering Practice	19	61.70	25.72	

Discussion

The evaluation data from the 2012-2013 LM-ROBO project generally show positive trends in reaching the desired results.

For adult facilitators: Improve the confidence and competence of adult 4-H volunteers in delivering engineering education.

The findings from both the workshop and the post-project evaluation data support the conclusion that this result was achieved. In general, the means to questions on the survey tend towards the "Agree" or "Strongly Agree" for many items. Taken together with the qualitative comments, it appears that many of the educators improved their confidence in their facilitation abilities including asking open-ended questions and helping youth investigate their own ideas while not using lectures or demonstrations.

Adults reported improving their abilities in helping youth investigate their own ideas. The workshop and post-project evaluations both found that one of the highest means and also one of the greatest pre-to-post mean increases was the question "I understand how to encourage youth to investigate their own questions and ideas." Given the fact that a few educators felt underprepared to facilitate and asked for more practice in "how to give direction without lecturing", seeing self-reported improvement, particularly in the post-project surveys, was a tremendous indication that these educators had given thought and attention in emphasizing learner-centered environments, a cornerstone of inquiry-based learning.

For youth: Improve young people's interest in and improved attitude in science and engineering.

Youth were interested in science and engineering before and after the project and generally seemed to know the primary differences between these two fields. Youth reported liking science and engineering, thought they will both be important in the young person's future, and expressed a desire to learn more about both. It was interesting to note that youth generally rated themselves more capable in the practices of engineering then they did in science, which might be attributed to their participation in an engineering education program. While there was not a statically significant improvement of science and engineering attitudes from beginning to end, this was more likely due to the limited sample size prohibiting the analysis from detecting changes.

Learning environment.

Youth reported that the learning environment allowed them to do hands-on activities, encouraged them to ask questions, and carry out investigations. These aspects of the learning environment are important components of inquiry-based learning and provided confirmation that educators were able to facilitate an environment where youth could investigate their own questions. This youth finding dovetails nicely with the adult self-reported outcome of encouraging youth to investigate their own questions. It appears that the LM-ROBO sites were able to implement a learner-centered environment.

Limitations

There were a number of limitations in this evaluation. First, the data presented here are of a correlational nature and do not imply causation. Second, the minimal sample size was disappointing and confirms the challenges of collecting evaluation data in these types of programs (i.e., relying on the adult volunteer educator to collect data). Third, there was a ceiling effect observed in the data evidenced by the negative skewness where data bunched at the high-end of the scale.

This evaluation sought to pilot test a Youth "Draw-a-Robot Test" (DART) which was adapted from the Draw-a-Scientist Test, an open-ended projective test used to assess youth perceptions of scientists (Chambers, 1983; Finson, 2002; 1995) and related to the Draw-an-Engineer Test (DAET; Weber et al., 2011). DART was intended to assess youth perceptions of robots. The limited response rate (pre, n=22; post, n=29) limited the ability to generate a coding scheme, a necessary component since there were no existing rubrics in the literature. There exists some potential to use a drawing test, similar to this, to assess youth perceptions and their change over time. For example, do youth draw humanoid robots more often that task-oriented robots (e.g., assembling a vehicle, disabling a bomb, etc.)? If so, would this change over time? One might hypothesize that a general perception of robots are humanoid but through an educational robotics intervention, youth may broaden their mental conception of robots.

References

Chambers, D.W. (1983). Stereotypic images of the scientist: The draw a scientist test. *Science Education 67* (2): 255–265

Falk, J. & Dierking, L. (2010). The 95 percent solution: School is not where most Americans learn most of their science. *American Scientist, 98*(6), 486-493.

Finson, K.D. (2002). Drawing a scientist: What we do and do not know after fifty years of drawings. *School Science and Mathematics, 102*(7): 335-345.

Finson, K. D., Beaver, J.B., Carmond, B.L. (1995). Development and field test of a checklist for the Draw-a-Scientist Test. *School Science and Mathematics, 95*(4): 195–205.

Fischer, R., & Milfont, T.L. (2010). Standardization in psychological research. *International Journal of Psychological Research, 3*(1), 88-96.

Grandgenett, N. (2010). *3rd external evaluation report* (and field test). University of Nebraska, Omaha.

Mahacek, R., Worker, S., & Mahacek, A. (2011). *Junk drawer robotics curriculum.* Chevy Chase, MD: National 4-H Council.

National Center for Education Statistics (2011). *The nation's report card: Science 2009*. (NCES 2011-451). Washington, D.C.: Institute of Education Sciences, U.S. Department of Education. Retrieved from: http://nces.ed.gov/nationsreportcard/pdf/main2009/2011451.pdf

National Research Council. (2009a). *Learning science in informal environments: People, places, and pursuits.* Washington DC: The National Academies Press.

National Research Council. (2009b). *Engineering in K-12 education: Understanding the status and improving the prospects.* Washington, DC: The National Academies Press.

Weber, N., Duncan, D., Dyehouse, M., Strobel, J., Diefes-Dux, H.A. (2011). The development of a systematic coding system for elementary students' drawings of engineers. *Journal of Pre-College Engineering Education Research, 1*(1), 49-62.

Appendices

Appendix 1: Draw-a-Robot Test & Open-Ended Questions
Appendix 2: Science & Engineering Survey.
Appendix 3: Survey for Project Leaders PRE-TEST
Appendix 4: Survey for Project Leaders POST-TEST

California 4-H Robotics

This study is being conducted by the University of California 4-H Youth Development Program in collaboration with the project leaders of your 4-H group. This survey will help us learn more about this program and what you learned.

This survey is voluntary. You don't have to participate if you don't want to.

You can stop at any time. You don't have to answer any questions you don't want to answer.

Thank you for your participation!

If you have any questions, please ask your project leader or contact Steven Worker, 4-H Science, Engineering, and Technology Coordinator at smworker@ucanr.edu.

University of California
Agriculture and Natural Resources
4-H Youth Development Program

Making a Difference for California

[This page left blank.]

Draw-A-Robot

Youth ID:____________________

Close your eyes and imagine a robot. In the space below, draw what you imagined.

Describe what the robot is doing in the picture.

List three words that come to mind when you think of a robot.

1.
2.
3.

[Turn Over the Page.] →

1. **What does a scientist do?**

2. **What does an engineer do?**

3. **What is the engineering design process?**

4. **What is a robot?**

5. **How are robots used in real life?**

6. **What jobs and careers use robots?**

7. **How could you use a robot in your life?**

California 4-H Robotics Youth Survey

Youth ID:_________________________

Please mark one: ☐ 4-H member ☐ 4-H adult volunteer ☐ Other

What is your age? _____ **Number of years in 4-H:** _____ **Gender:** ☐Male ☐Female

☐ White ☐ Black ☐ Hispanic/Latino/a ☐ Native American ☐ Asian/Pacific Islander

Where do you live? ☐ City ☐ Suburb ☐ Town ☐ Rural ☐ Farm

Please check one for each question

1. I like science
☐ Strongly Disagree ☐ Disagree ☐ Agree ☐ Strongly Agree

2. I am good at science
☐ Strongly Disagree ☐ Disagree ☐ Agree ☐ Strongly Agree

3. I would like to have a job related to science in the future
☐ Strongly Disagree ☐ Disagree ☐ Agree ☐ Strongly Agree

4. I do science-related activities that are not for schoolwork
☐ Strongly Disagree ☐ Disagree ☐ Agree ☐ Strongly Agree

5. I think science will be important in my future
☐ Strongly Disagree ☐ Disagree ☐ Agree ☐ Strongly Agree

6. Science is useful for solving everyday problems
☐ Strongly Disagree ☐ Disagree ☐ Agree ☐ Strongly Agree

7. Science is one of my favorite subjects
☐ Strongly Disagree ☐ Disagree ☐ Agree ☐ Strongly Agree

8. I like to see how things are made or invented
☐ Strongly Disagree ☐ Disagree ☐ Agree ☐ Strongly Agree

9. I like experimenting and testing ideas
☐ Strongly Disagree ☐ Disagree ☐ Agree ☐ Strongly Agree

10. I get excited about new discoveries
☐ Strongly Disagree ☐ Disagree ☐ Agree ☐ Strongly Agree

11. I want to learn more about science
☐ Strongly Disagree ☐ Disagree ☐ Agree ☐ Strongly Agree

12. I like to watch television programs about science
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

How long have you been doing 4-H Robotics? _____________________________

13. I like to talk about science with my friends
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

14. I can use scientific data to form a question
☐ Never ☐ Sometimes ☐ Usually ☐ Always

15. I can design a scientific procedure to answer a question
☐ Never ☐ Sometimes ☐ Usually ☐ Always

16. I can use data to create a graph for presentation to others
☐ Never ☐ Sometimes ☐ Usually ☐ Always

17. I can create a display to communicate my data and observations
☐ Never ☐ Sometimes ☐ Usually ☐ Always

18. I can use science terms to share my results
☐ Never ☐ Sometimes ☐ Usually ☐ Always

19. In my 4-H projects, I get to do hands-on activities
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

20. In my 4-H projects, I am encouraged to ask questions
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

21. In my 4-H projects, I get to plan and carry out investigations
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

22. In my 4-H projects, I have helped with a community service project that relates to science *(for example: planted trees or garden, road or stream clean-up, recycling)*
☐ Yes ☐ No

23. In my 4-H projects, I used science tools to help in the community
(for example: mapped with GIS, tested water quality)
☐ Yes ☐ No

24. In my 4-H projects, I taught others about science
(for example: demonstrated, gave presentation, led a project)
☐ Yes ☐ No

25. In my 4-H projects, I organized or led science-related events
(for example: science fair, environmental festival)
☐ Yes ☐ No

26. I like engineering
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

27. I am good at engineering
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

28. I would like to have a job related to engineering in the future
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

29. I do engineering-related activities that are not for schoolwork
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

30. I think engineering will be important in my future
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

31. Engineering is useful for solving everyday problems
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

32. Engineering is one of my favorite subjects
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

33. I like to build and construct things
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

34. I want to learn more about engineering
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

35. I like to watch television programs about engineering
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

36. I like to talk about engineering with my friends
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

37. I can identify engineering problems
☐ Never ☐ Sometimes ☐ Usually ☐ Always

38. I can generate ideas and possible solutions
☐ Never ☐ Sometimes ☐ Usually ☐ Always

39. I can evaluate and compare possible solutions
☐ Never ☐ Sometimes ☐ Usually ☐ Always

40. I can select a solution, develop and refine the design selected
☐ Never ☐ Sometimes ☐ Usually ☐ Always

41. I can evaluate or test the design
☐ Never ☐ Sometimes ☐ Usually ☐ Always

42. I can communicate the final product
☐ Never ☐ Sometimes ☐ Usually ☐ Always

Revised September 24, 2012.
4-H Science, Engineering, and Technology Common Measure
State 4-H Office, Steven Worker at smworker@ucanr.edu

JUNK DRAWER ROBOTICS

2012-2013 California 4-H LM-ROBO Sites

Survey For Project Leaders & Teen Leaders

PRE-Project

Adult ID:_________________________

County & Club Name	
Project Name	
Gender	☐ Male ☐ Female
Status	☐ 4-H adult volunteer ☐ 4-H teen leader ☐ Community Partner
Have you participated in 4-H Junk Drawer Robotics workshops before?	❑ Yes, when? _______________ ❑ No
Have you led 4-H Junk Drawer Robotics projects before?	❑ No ❑ Level 1: Give Robots a Hand ❑ Level 2: Robots on the Move ❑ Level 3: Mechatronics
I was satisfied with today's workshop. ☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree	
Did this workshop enhance your abilities as an educator? ☐ Not at all ☐ A little ☐ Somewhat ☐ Mostly ☐ Absolutely	
As a result of today's workshop, in what topic do you feel most prepared?	
In what area do you feel you need additional preparation?	
What modifications, if any, would you make to the workshop?	

1a. I understand how to use open-ended questions for inquiry-based teaching, such as "What do you know about robots? ☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree
1b. *Before participating in this workshop* I understood how to use open-ended questions for inquiry-based teaching, such as "What do you know about robots? ☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree
2a. I understand how to encourage youth to investigate their own questions and ideas. ☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree
2b. *Before participating in this workshop* I understood how to encourage youth to investigate their own questions and ideas. ☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree
3a. I understand how to encourage youth to explore questions and ideas derived from their own experiences. ☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree
3b. *Before participating in this workshop* I understood how to encourage youth to explore questions and ideas derived from their own experiences. ☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree
4a. I understand how to encourage youth to use science and engineering terms and concepts. ☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree
4b. *Before participating in this workshop* I understood how to encourage youth to use science and engineering terms and concepts. ☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree
5a. I understand how to ask youth to explain their thinking. ☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree
5b. *Before participating in this workshop* I understood how to ask youth to explain their thinking. ☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree
6a. I understand how to help youth discuss the concepts of a lesson after completion of an activity. ☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree
6b. *Before participating in this workshop* I understood how to help youth discuss the concepts of a lesson after completion of an activity. ☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree
7a. I understand how to ask probing questions to redirect youths' investigations. ☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree
7b. *Before participating in this workshop* I understood how to ask probing questions to redirect youths' investigations. ☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree
8a. I understand how to act as a facilitator for youth as they work on their activities. ☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree
8b. *Before participating in this workshop* I understood how to act as a facilitator for youth as they worked on their activities. ☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree
9a. I understand how to help youth develop observation skills in order to collect good scientific data. ☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree
9b. *Before participating in this workshop* I understood how to help youth develop observation skills in order to collect good scientific data. ☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

10a. I understand how to encourage youth to apply skills in new situations.
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

10b. *Before participating in this workshop* I understood how to encourage youth to apply skills in new situations.
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

11a. I understand how to create opportunities for youth to work together without direct instruction from me.
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

11b. *Before participating in this workshop* I understood how to create opportunities for youth to work together without direct instruction from me.
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

12a. I understand how to encourage youth to use scientific knowledge to form a question.
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

12b. *Before participating in this workshop* I understood how to encourage youth to use scientific knowledge to form a question.
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

13a. I understand how to encourage youth to apply concepts they learn to new situations.
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

13b. *Before participating in this workshop* I understood how to encourage youth to apply concepts they learn to new situations.
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

14a. I understand how to begin activities with broad, open-ended questions that are focused on the concept(s) of the activity.
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

14b. *Before participating in this workshop* I understood how to begin activities with broad, open-ended questions that are focused on the concept(s) of the activity.
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

15a. I understand how to help youth develop communication skills to report data and observations.
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

15b. *Before participating in this workshop* I understood how to help youth develop communication skills to report data and observations.
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

16a. I understand how to teach youth using techniques **other** than lectures or demonstrations.
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

16b. *Before participating in this workshop* I understood how to teach youth using techniques **other** than lectures or demonstrations.
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

17a. I understand how to encourage youth to use the results of their investigations to answer their own questions.
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

17b. *Before participating in this workshop* I understood how to ask encourage youth to use the results of their investigations to answer their own questions.
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

18a. I understand how to help youth use the engineering design process to solve a problem.
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

18b. *Before participating in this workshop* I understood how to help youth use the engineering design process to solve a problem.
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

JUNK DRAWER ROBOTICS

2012-2013 California 4-H LM-ROBO Sites

Survey For Project Leaders & Teen Leaders

POST-Project

Adult ID:_______________________

County & Club Name	
Project Name	
Gender	☐ Male ☐ Female
Status	☐ 4-H adult volunteer ☐ 4-H teen leader ☐ Community Partner
How often did your project meet? ☐ More than once a week ☐ Once a week ☐ Every other week ☐ Once a month ☐ Other: _______________	
What was your project's duration? Number of months: ______________________	
Which training did you participate in?	☐ None ☐ Previous Year (which year? __________) ☐ November 17, 2012 ☐ December 1, 2012
How did the training prepare you to lead the curriculum? What worked and what additional preparation did you need?	
Describe what worked well overall.	
Describe what did not work overall.	

Describe how, if at all, you made adjustments to the curriculum.	
How did you recruit youth to participate?	
What do you think youth liked about the curriculum?	
What did they dislike – what could be better?	
Any other comments about 4-H Junk Drawer Robotics?	

Please mark completed activities.

Level 1: Give Robots a Hand	Level 2: Robots on the Move	Level 3: Mechatronics
☐ Activity A: Think Like a Scientist	☐ Activity A: Slip N Slide	☐ Activity A: Series/Parallel
☐ Activity B: Communicate Like an Engineer	☐ Activity B: Rolling Along	☐ Activity B: Off and On
☐ Activity C: Build Like a Technician	☐ Activity C/D: Clipmobile	☐ Activity C: Direction of Flow
☐ Activity D/E: Marshmallow Catapult	☐ Activity E: Light Up My Life	☐ Activity D/E: Forward and Reverse
☐ Activity F: Sense of Balance	☐ Activity G/H: Can-Can Robot	☐ Activity F: Line Follower
☐ Activity G: ABC…XYZ	☐ Activity I: Gear We Go Again	☐ Activity G: Keep in Touch
☐ Activity H/I: Arm in Arm	☐ Activity J: Gears and More Gears	☐ Activity H: Don't Buzz Me!
☐ Activity J: Pumped Up	☐ Activity K/L: Gear Train	☐ Activity I/J: Wall Follower
☐ Activity K/L: Just Add Air	☐ Activity M/N: Es-Car-Go	☐ Activity K: It's About Time
☐ Activity M: Chopsticks	☐ Activity O: Pennies in a Boat	☐ Activity L: Logic: ANR, OR, NOT!
☐ Activity N: Just a Pinch	☐ Activity P: Sink or Float	☐ Activity M: Analog vs. Digital
☐ Activity O: Hold On	☐ Activity Q/R: Sea Hunt	☐ Activity O: Breadboard
☐ Activity P/Q: One for the Gripper	☐ Activity S: To Make the Best Better	☐ Activity P: Cashier
☐ Activity R/S: Twist of the Wrist		☐ Activity Q: Walk the Walk
		☐ Activity R/S: Say What?
		☐ Activity T/U: Build Your Robot

1a. I understand how to use open-ended questions for inquiry-based teaching, such as "What do you know about robots?
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

1b. *Before facilitating the 4-H Junk Drawer Robotics curriculum I* understood how to use open-ended questions for inquiry-based teaching, such as "What do you know about robots?
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

2a. I understand how to encourage youth to investigate their own questions and ideas.
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

2b. *Before facilitating the 4-H Junk Drawer Robotics curriculum I* understood how to encourage youth to investigate their own questions and ideas.
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

3a. I understand how to encourage youth to explore questions and ideas derived from their own experiences.
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

3b. *Before facilitating the 4-H Junk Drawer Robotics curriculum I* understood how to encourage youth to explore questions and ideas derived from their own experiences.
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

4a. I understand how to encourage youth to use science and engineering terms and concepts.
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

4b. *Before facilitating the 4-H Junk Drawer Robotics curriculum I* understood how to encourage youth to use science and engineering terms and concepts.
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

5a. I understand how to ask youth to explain their thinking.
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

5b. *Before facilitating the 4-H Junk Drawer Robotics curriculum I* understood how to ask youth to explain their thinking.
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

6a. I understand how to help youth discuss the concepts of a lesson after completion of an activity.
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

6b. *Before facilitating the 4-H Junk Drawer Robotics curriculum I* understood how to help youth discuss the concepts of a lesson after completion of an activity.
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

7a. I understand how to ask probing questions to redirect youths' investigations.
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

7b. *Before facilitating the 4-H Junk Drawer Robotics curriculum I* understood how to ask probing questions to redirect youths' investigations.
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

8a. I understand how to act as a facilitator for youth as they work on their activities.
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

8b. *Before facilitating the 4-H Junk Drawer Robotics curriculum I* understood how to act as a facilitator for youth as they worked on their activities.
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

9a. I understand how to help youth develop observation skills in order to collect good scientific data.
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

9b. *Before facilitating the 4-H Junk Drawer Robotics curriculum I* understood how to help youth develop observation skills in order to collect good scientific data.
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

10a. I understand how to encourage youth to apply skills in new situations.
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

10b. *Before facilitating the 4-H Junk Drawer Robotics curriculum I* understood how to encourage youth to apply skills in new situations.
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

11a. I understand how to create opportunities for youth to work together without direct instruction from me.
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

11b. *Before facilitating the 4-H Junk Drawer Robotics curriculum I* understood how to create opportunities for youth to work together without direct instruction from me.
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

12a. I understand how to encourage youth to use scientific knowledge to form a question.
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

12b. *Before facilitating the 4-H Junk Drawer Robotics curriculum I* understood how to encourage youth to use scientific knowledge to form a question.
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

13a. I understand how to encourage youth to apply concepts they learn to new situations.
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

13b. *Before facilitating the 4-H Junk Drawer Robotics curriculum I* understood how to encourage youth to apply concepts they learn to new situations.
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

14a. I understand how to begin activities with broad, open-ended questions that are focused on the concept(s) of the activity.
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

14b. *Before facilitating the 4-H Junk Drawer Robotics curriculum I* understood how to begin activities with broad, open-ended questions that are focused on the concept(s) of the activity.
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

15a. I understand how to help youth develop communication skills to report data and observations.
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

15b. *Before facilitating the 4-H Junk Drawer Robotics curriculum I* understood how to help youth develop communication skills to report data and observations.
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

16a. I understand how to teach youth using techniques **other** than lectures or demonstrations.
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

16b. *Before facilitating the 4-H Junk Drawer Robotics curriculum I* understood how to teach youth using techniques **other** than lectures or demonstrations.
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

17a. I understand how to encourage youth to use the results of their investigations to answer their own questions.
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

17b. *Before facilitating the 4-H Junk Drawer Robotics curriculum I* understood how to ask encourage youth to use the results of their investigations to answer their own questions.
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

18a. I understand how to help youth use the engineering design process to solve a problem.
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree

18b. *Before facilitating the 4-H Junk Drawer Robotics curriculum I* understood how to help youth use the engineering design process to solve a problem.
☐ Strongly Disagree ☐ Disagree ☐ Neither Agree nor Disagree ☐ Agree ☐ Strongly Agree