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Building Life Skills and Interest in STEM Through Rural 4-H Robotics Camps

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Building Life Skills and Interest in STEM Through Rural 4-H Robotics Camps

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Many rural communities are looking for inexpensive and innovative ways to engage youth in science, technology, engineering, and mathematics (STEM). University Extension 4-H programs offer a unique platform to increase rural youth exposure to STEM and build important life skills. This study employed a mixed-methods approach to examine ways in which 47 youth in five rural robotics day camps grew in targeted 4-H life skills and enthusiasm for science. Campers perceived growth in their decision making and ability to use limited resources during these short day camps. Furthermore, participant observations and responses to open-ended prompts in their "science notebooks" provided insight as to potential mechanisms for this growth and behavioral patterns that enhanced the camper experience. We argue that increasing STEM knowledge and skills alone is not sufficient and that future STEM-focused programs should also target life skills such as decision making, teamwork, and communication.

Keywords: youth development, STEM, life skills, robotics, rural, 4-H

Introduction

National leaders, educators, and policymakers seek unique solutions to increase student performance in the areas of science, technology, engineering, and mathematics (STEM) that will lead to increased interest in and preparation for university. This is increasingly important in rural places where a gap in exposure to and opportunity in advanced STEM inquiry exists compared to nonrural places (Byun, Meece, & Irvin, 2012; Provasnik et al., 2007). Recently, scholars have argued that STEM skills and related occupations are particularly well-suited for rural young adults who want to return home (Meece et al., 2013; Peterson, Bornemann, Lydon, & West, 2015), and recent results from the U.S. Department of Agriculture (USDA, 2016) suggest a growing need for workers with STEM expertise in the four pillars of rural economic development: the bio-based economy, conservation markets, local and regional food systems, and agricultural production.

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The 2004 4-H Science Initiative challenged faculty and program managers to construct and deliver fun and engaging opportunities in STEM (Mielke, Butler, & LaFleur, 2010). According to 4-H policy (WSU 4-H Youth Development Program, 2018), the goal of 4-H is to develop self-directing, productive, contributing, caring members of society by emphasizing growth in areas such as communication, responsibility to self and community, and decision making. To build interest and skills in both STEM and general life skills, 4-H utilizes projects and opportunities that rely on experiential learning (Kolb, 1984), a teaching approach which uses hands-on experience to encourage deeper understanding and integration of skills.

In the years since the 4-H Science Initiative, 4-H commissioned a number of mostly quantitative, large scale studies to assess system capacity for delivering STEM-related programming, implementation, and youth engagement, attitudes, and knowledge (Boscia, 2012; Locklear, 2013; Mielke et al., 2010; Mielke & Butler, 2013). However, these studies were not focused at the program or county level and did not address the nuanced ways youths' specific life skills develop alongside growing interest and skills in STEM activities. The present mixed-methods study used surveys, participant observation, and reflective writing to explore the experiences of 47 participants, ages 7-12, who participated in five summer robotic camps in eastern Washington.

Literature Review

Previous research suggests that early and positive exposure to STEM increases the likelihood that individuals pursue STEM-related degrees and subsequent careers (Maltese & Tai, 2011; van Langen & Dekkers, 2005; Wai, Lubinski, BenBow, & Steiger, 2010). Unfortunately, partly because of the higher investment costs for fewer students, rural schools are less likely to have these early opportunities or specialized classes in STEM areas than their nonrural counterparts (Provasnik et al., 2007). Early interest in STEM and a K-12 student's career expectations are significant indicators of his or her likelihood of completing a STEM degree. Stereotypes of STEM as too difficult, inaccessible, and unglamorous have been found to deter students from pursuing STEM fields later in life (van Langen & Dekkers, 2005). Enriching experiences, such as the rural 4-H robotics camps studied here, may help combat negative stereotypes by offering fun, hands-on engagement and positive role models.

Current Literature on Rural Robotics Programs

To date, there has been limited and varied scholarship on the impacts of using robotics curricula in afterschool or camp settings in rural places. Study methods involving mostly middle school children have ranged from describing a specific implementation technique and reporting on the results of a satisfaction-based evaluation (Ivey & Quam, 2009) to a pre-test/post-test quasi-experimental design in a small rural community (Barker & Ansorge, 2007). In the assessment of "The Robot Roadshow Program" in Kansas, Matson, DeLoach, and Pauly (2004) visited rural schools and collected pre-visit and follow-up data with more than 1,000 rural students. Other research has primarily relied on behavioral observation (Blanchard, Freiman, & Lirrete-Pitre, 2010). One mixed methods study of a 2-week robotics camp for middle school children used content knowledge measures, facilitator focus groups, interviews, and reflections as well as researcher observation (Williams, Ma, Prejean, Ford, & Lai, 2007).

Among the existing studies, how outcomes are measured and how findings are reported also varies widely. Ivey and Quam (2009) utilized comments from feedback forms administered to parents and participants after a one-week program, which returned a great deal of positive commentary. While they did not empirically assess their target areas, the authors described purposefully designing their curriculum to enhance skills that Wagner (2008) argues are key for success in STEM fields, including critical thinking, problem solving, collaboration, entrepreneurialism, communication, accessing and analyzing information, curiosity, and imagination. Other researchers assessing gains in content knowledge found robotics camps had positive effects on physics knowledge but not on broader scientific inquiry skills (Williams et al., 2007), while research on a curriculum integrated into an afterschool 4-H program found significant gains in specific robotics knowledge (Barker & Ansorge, 2007). Further research is needed to understand the experiences of those attending these camps and clarify potential outcomes.

Experiential Learning and 4-H Life Skills

Kolb's (1984) experiential learning theory provides a frame for much of the work conducted in 4-H and thus this project. For decades, leaders and volunteers have recognized the importance of having children and youth learn by doing and reflecting. Building on the learning and cognitive theories of Lewin, Dewey, and Piaget, Kolb (1984) argued that learning is more of a process than an outcome shaped and reshaped through experience and assessment. His groundbreaking assertions asked educators to engage students as active learners who learn best through making sense of tensions and conflicts in their understandings of the world. In terms of program implementation, the current study relies on Woffinden and Packham's (2001) five-step model for maximizing the effects of experiential learning. First, students need to have *experience* with the concepts or information; preferably a hands-on, student-directed experience. Second, students are more likely to fully engage with the new knowledge if they *share* what they have learned. Next, educators need to create space for students to *process* the new information in different mediums (e.g., verbal, written). Finally, educators should help students understand how to *generalize* and *apply* the new knowledge to other situations.

Given that youth interest in STEM topics and fields wanes over time (Brotman & Moore, 2008) and early positive exposure is important in predicting future interest (Maltese & Tai, 2011; van Langen & Dekkers, 2005; Wai et al., 2010), 4-H leaders and volunteers in eastern Washington have rallied over the past several years to bring introductory-level robotics experiences to isolated rural communities in hopes of growing targeted life skills and encouraging interest in robotics and STEM activities among rural youth. For this pilot evaluative study, we assessed five camps conducted by Extension faculty and student intern facilitators over six weeks during the summer of 2014. Depending on feasibility, the length of the camps, as well as curriculum and evaluation implementation, varied across locations. Limitations in the interpretation of our findings based on these variations are discussed.

The objective of these 4-H robotics camps was to grow targeted life skills and pique student interest in fields related to technological innovation that are critical for the U.S. rural economy. Geared toward individuals in isolated rural communities, campers encountered unique experiences in STEM that were otherwise not locally available. With this in mind, we utilized a variety of methods to investigate self-reported and observed beliefs and behaviors related to five areas of development: decision making skills, ability to use limited resources, communication skills, teamwork, and enthusiasm for science. This study expands on existing literature by examining life skills that are essential to utilize gains in STEM knowledge and skills.

Methods

To understand the complex nature of delivering science and engineering programming in rural communities, a mixed-methods approach was used. Results are based on three methods: (1) a quantitative end-of-program survey, (2) participant observation, and (3) participant free-writing responses to open-ended prompts. Variations in facilitator implementation of these three evaluation methods due to feasibility are discussed below. This project was determined exempt from review by the Washington State University's Institutional Review Board; however, researchers and facilitators followed informed consent protocol for all participants as described below.

The Camp Experience

The robotics camp curriculum utilized age-appropriate experiential learning and fostered scientific inquiry. For these camps, facilitators designed lesson plans with the intention to move campers from learning the basics of robotics to demonstrating their new skills. Youth ages 8-12 years old participated in an Introduction to Robotics day camp in five rural communities in eastern Washington. Participants in the day camps were first asked to select a First Lego League game initiative[1] and then design a Lego robot to accomplish the task. Each camp began with introductory hands-on activities among camper teams to learn elements of building and

[1] One of several tasks implemented in First Lego League youth competitions; these activities are designed to challenge participants to design and program their robot to accomplish a prescribed task, such as designing a forklift on the Lego robot to save a paper cow.

programming Lego robots before designing and building a robot to "battle" against other teams. Over the course of the camps, teams of three campers engaged in conceptualizing a design, building, programming, and finally testing their robot. At the conclusion of the camp, campers demonstrated their robot's abilities to fellow campers, family, and camp facilitators and discussed their challenges and lessons learned. During these camp experiences, campers were guided and supported by camp facilitators and trained volunteers. Camp leaders allowed the youth to learn through processing, generalizing, applying, and reflecting on their knowledge. Youth learned how to build sophisticated robots, while also learning important 4-H life skills such as decision making, ability to use limited resources, communication, and teamwork.

Recruitment

All names of towns and individuals have been changed to protect the confidentiality of the participants. The five communities in this study are predominately white with economies based on agricultural production. While these communities have a number of characteristics in common, each of the locations presented unique challenges and opportunities. Table 1 briefly outlines some key characteristics, drawn primarily from the U.S. Census (2010) and the Washington State Office for the Superintendent of Instruction (2014). Community sizes range from 400 to about 2,800, with child poverty rates ranging from nearly zero to one in four.

Table 1. Select Characteristics of Five Communities Where Camps Were Facilitated

Town	Population	Family poverty rate (2010)	K-12 enrollment	Free/ reduced lunch rate	Math scores* WA average = 53.3	Science scores* WA average = 64.9
Granger	1,500	20%	300	53%	30.4	69.9
Waverly	2,500	14%	400	55%	40.0	63.6
Campton	2,800	33%	600	35%	47.1	56.9
Wheatly	400	4%	200	17%	42.9	50.0
Riverside	1,200	25%	600	30%	62.5	83.3

* Math and science scores based on 8th grade standardized test.

Table 2 summarizes the data collected during each of the camps. Facilitators were not able to collect as much data at the Riverside camp as other camps because the camp was coordinated with a general day camp that made directing break and snack time activities more difficult.

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Table 2. Quantity of Data Collected By Camp and Type

	Decision Making			**Limited Resources**			**Communication**			**Teamwork**			**Enthusiasm**		
	sur	obs	nb	sur	obs	nb	sur	obs	nb	sur	obs	nb	sur	obs	nb
Granger	8	0	6	8	0	7	6	0	0	6	0	7	6	0	0
Waverly	7	2	0	7	1	0	4	2	8	4	4	0	5	2	9
Campton	7	3	10	8	4	9	4	5	9	4	4	10	7	3	9
Wheatly	11	2	10	11	0	11	8	4	0	8	6	10	10	6	0
Riverside	8	4	0	9	0	0	0	2	0	0	5	10	0	4	0
Totals	**41**	**11**	**26**	**43**	**5**	**27**	**22**	**13**	**17**	**22**	**19**	**37**	**28**	**15**	**18**

Note: "sur" denotes survey, "obs" denotes observation, and "nb" denotes notebook.

In each of the communities, campers were recruited through 4-H meetings, flyers, and word of mouth. When parents brought their children on the first day of camp, camp facilitators explained that the robotics camp was involved in a research project and requested parents' permission for their children to complete the survey and to be observed for the purpose of the study. A copy of the participant survey was available at all camps for review. Camp facilitators explained how confidentiality would be maintained and that children's private or identifying information would not be linked to their answers or actions. Once camp facilitators obtained written parental consent, they explained the study to the participating youth and obtained verbal youth permission. Camp facilitators emphasized the voluntary nature of the study.

Procedures

The multiple sources of data utilized in this study allow for triangulation to compensate for weaknesses in each approach, while capitalizing on the strengths of the selected methods. The end-of-program quantitative survey provided participants with the opportunity to reflect on the camp in a more structured and systematic way. Participatory observation conducted by the facilitators yielded rich details about the contexts of each camp and the nature of the interactions between camp participants in relation to the variables of interest in this study. Finally, free-writing opportunities allowed participants to reflect subjectively on their own experiences in a less structured way during the camp – some of which coincided with the observations of camp facilitators (measurement tools available upon request). The combination of these three methods provided structured quantitative data and less-structured qualitative data that, when combined and analyzed in relation to each other, provided a more holistic picture of the overall camp experience and outcomes.

End-of-program Survey

Camp participants were invited to complete a six-page end-of-program survey on the last day of camp. This post-then-pre survey, also known as a retrospective survey, comprised the same five

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topics assessed through participant observation and freewriting prompts: decision making, use of limited resources, communication, teamwork, and enthusiasm for science. Participants first indicated their current (posttest) endorsements of the statements for each of the five topics, and immediately afterward indicated their perceptions of how they believe they would have responded to the statements before attending the camp. This post-then-pre survey tool was utilized to minimize the risk of response bias shift (Howard, Dailey, & Gulanick, 1979) or the concern that respondents would not "know what they don't know" prior to the camp and therefore would not respond similarly in a traditional pretest/posttest design. Furthermore, we were interested in youths' own perceptions of their growth, as prior work has linked youths' positive perceptions of their own growth to greater interest and willingness to persist in science coursework and participate in science-related activities (Maltese & Tai, 2011; Wai et al., 2010).

Scales for the survey measures were drawn from multiple sources and are discussed below. The majority were adapted from parts of the Youth Engagement, Attitudes, and Knowledge survey (YEAK), conducted in 2009 and 2011 in relation to the 2004 4-H Science Initiative (Mielke et al., 2010; Mielke & Butler, 2013).

Decision making scale. We measured decision making with the post-then-pretest format, using the YEAK 5-item scale (alpha = .77). Campers were asked to indicate how much they agreed on a scale of 1 = *strongly disagree* to 5 = *strongly agree* with statements related to making decisions such as, "When I have a decision to make, I think before making a choice" and "When I have a decision to make, I consider the risks of a choice before making a decision," first for how they currently felt about the statements and then about how they felt prior to the robotics camp (post-then-pretest design).

Use of limited resources. Part of what campers must negotiate in a robotics camp is the lack of resources to accommodate all of their ideas. Because a measure of this concept does not currently exist, we created three items, two positively-stated items (e.g., I know how to use the resources I have to solve a problem) and one negatively-stated item (I get frustrated when I don't have the right tools or materials) to measure use of limited resources. Campers were asked to rate how much they agreed with these three statements on a scale of 1 = *strongly disagree* to 5 = *strongly agree*. While answers to these questions were expected to be related, alpha scores were too low to construct them as a scale. Thus, they were assessed individually.

Communication. Similar to decision making, campers were asked to respond to five questions regarding their listening and talking behaviors when interacting with others drawn from the YEAK survey (e.g., When communicating…I listen when someone is talking to me) on a scale of 1 = *never* to 4 = *always* for both after and before the camp. Like the use of limited resources measures, items could not be used to construct a scale, as the alpha scores were also too low. Thus, they were considered as independent items for analysis.

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Teamwork. To measure teamwork, we modified questions from the Youth Experiences Survey (Hansen & Larson, 2005). Campers were asked to report on five items, including questions on being able to compromise, share responsibility, and be patient. Campers answered five questions regarding teamwork on a scale of 1 = *never* to 4 = *always* for after and before the camp (alpha = 0.80).

Enthusiasm for science. To measure enthusiasm for science, campers were asked to complete an 18-item scale in the post-then-pretest format (alpha = 0.91). Campers indicated how much they agreed with the statements on a scale of 1 = *strongly disagree* to 5 = *strongly agree*. Items included statements such as, “I like to work on science activities” and “Science is something I get excited about.” One item, “Science is boring,” was reverse coded to match the direction of the remaining 17 items.

Data from the retrospective post-then-pretest survey were entered into STATA. Mean pretest and posttest scores from the three scales and eight single items were compared using paired-samples *t*-tests to assess statistically significant differences. Because of the small sample size, data from the five camps were combined to increase analytical power for these preliminary analyses. Effect sizes for the pre–post differences in this survey were calculated using Hedge’s *g,* as it provides a less biased estimate of the standardized mean difference in cases with smaller sample sizes (Hedges & Olkin, 1985). The magnitude of Hedge’s *g* was interpreted using Cohen’s (1988) convention as small (0.2), medium (0.5), and large (0.8).

Participant Observation

Camp facilitators trained in observation techniques used a field notebook to briefly record occasions where they observed camp participants engaging in positive or negative behavior related to (a) decision making (e.g., asking questions to consider different aspects of a building or programming decision), (b) use of limited resources (e.g., considering the pieces needed to accomplish a task), (c) communication (e.g., ability or inability to discuss ideas or resolve an argument), (d) teamwork (e.g., assigning and taking on a role in a team), and (e) enthusiasm for science (e.g., expressing enthusiasm or discouragement toward building or programming through verbal or behavioral cues). After each day of camp, camp facilitators used their brief handwritten field notes to elaborate on the event in an electronic version of the field notebook.

To analyze the field notes, initial steps of the grounded theory approach (Corbin & Strauss, 1990) were employed to detect themes. The principle investigator and one co-investigator initially coded individual entries for emerging themes and topics using HyperResearch, Microsoft Word, and Excel. As codes were selected, researchers also compiled analytical memos (notes on how codes were selected, what the researcher felt the code meant, and how it was connected to or embedded in other codes) to inform overall findings. Once initial coding

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was complete, the team reviewed the coding and discussed how best to frame the findings as they are situated in the larger literature on engaging youth in nonschool-based STEM activities.

Science Notebooks

All camp participants were asked at transition times during each camp day to complete questions in their science notebook. Not every question was answered at each camp (with the exception of Campton). The science notebooks were kept at camp and did not go home with participants. Entries in the science notebooks were transcribed and organized according to the five target areas (decision making skills, ability to use limited resources, communication skills, teamwork, and enthusiasm for science) to be coded for themes by the authors (see Appendix A for questions). Participants' freewriting answers to science notebook questions were connected to observations made by research assistants through confidential codes when appropriate. The data from these notebooks were assessed in the same manner as the field notes described above.

Results

A brief overview of results related to the four 4-H life skills (decision making skills, ability to use limited resources, communication, and teamwork) and enthusiasm for science follows. The results section is organized according to the five target areas, first highlighting the survey findings (see Table 3) then triangulating qualitative coding results from facilitators' observations and entries in the science notebooks (see Table 4) to complement quantitative findings. In total, camp facilitators recorded 97 field note entries and collected 171 science notebook entries from campers across the five summer camps. Forty-six of the 47 camp participants completed at least a portion of the post-then-pre survey on the final day of camp (see Table 2). Forty percent (n = 20) of the campers were girls and the majority (80%) were white. Campers' ages ranged from 7 to 14 (M = 10.35 years). About half (55%) of the campers were between the ages of 10 and 12.

4-H Life Skills

As described in the Methods section, campers responded to a number of closed-ended survey and open-ended science notebook questions in relation to the four target 4-H life skills (decision making, ability to use limited resources, communication, and teamwork) and enthusiasm for science. Unfortunately, due to time constraints and participant fatigue, not all campers answered all survey questions. In some camps, there was not enough time for the facilitators to incorporate science notebook prompts (especially when camps were only 2 or 3 days long). In other camps, campers only had time to get through the beginning of the quantitative survey (thus there are fewer responses to the questions regarding enthusiasm for science, which came towards the end of the survey). Despite these shortcomings, this pilot project yielded some interesting findings, providing insight into future investigation.

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Decision making. Responses to the survey indicated a statistically significant increase in campers' perceptions of their own decision making skills ($t = 2.89$, $p = 0.001$, Hedge's $g = 0.33$), with average scores increasing from 2.66 to 2.88 (see Table 3). The Hedge's *g* effect size indicates this is a small but substantial difference when adjusting for the small sample size.

Table 3. Summary of Survey Mean Differences, t-test, and Hedge's G Scores

Variable (number of respondents)	**Pre µ (*SD*)**	**Post µ (*SD*)**	***t***	***g***
Decision Making Scale (*n* = 37)	2.66 (0.69)	2.88 (0.64)	2.89***	0.33
Limited Resources (*n* = 40)				
I know how to use the resources I have to solve a problem.	2.63 (0.86)	3.00 (0.69)	2.47**	0.47
When there is not much to work with, I can be creative in using my resources.	2.98 (0.90)	3.33 (0.89)	3.96***	0.39
I get frustrated when I don't have the right materials or tools.	2.27 (1.00)	2.13 (1.02)	-0.63	-0.14
Communication (*n* = 23)				
I listen when someone is talking to me.	3.09 (0.51)	3.00 (0.74)	-0.57	-0.14
I tell people how I feel when they hurt my feelings.	2.00 (0.90)	2.00 (1.00)	0.00	0.00
I apologize when I am wrong.	2.73 (1.00)	2.78 (0.95)	0.44	0.05
I get along with people.	2.91 (0.67)	3.00 (0.67)	1.45	0.16
I ask for help if I do not understand something.	2.74 (0.96)	2.82 (1.00)	0.83	0.08
Teamwork (*n* = 21)	3.01 (0.59)	3.08 (0.62)	0.56	0.11
Enthusiasm for Science Scale (*n* = 16)	3.35 (0.94)	3.65 (1.13)	2.03**	0.28

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Qualitatively, facilitators observed instances of decision making with all campers as they designed, built, and programmed their Lego Robot to perform specified tasks. Common strategies for making decisions when problems arose included improvising through substituting Lego pieces or the process of trial and error, asking for help, and allowing a teammate to try an idea. Facilitators observed campers testing out parts or programming sequences before deciding with feature worked best. Facilitators also observed youth consulting with adults or their instruction booklet for additional information. For example, when making a decision regarding part size, one youth discovered both the axle measuring device and the graphic in the booklet are scaled 1:1 – youth could have used either option to select and measure for the correct size. Finally, almost half of the science notebook entries on decision making mentioned instances where they tried different things before selecting one option over the others.

Table 4. Emerging Themes Based on Observations and Science Notebook Entries

4-H Life Skill	Emerging Themes
Decision Making	Trial and error or testing multiple strategies Asking for help Letting another person try
Use of Limited Resources	Adapting original idea Adapting resources to maintain original idea
Communication	Being positive Being assertive
Teamwork	Taking turns Feeling included

Use of limited resources. On the survey, campers reported experiencing a significant increase on two of the three items indicating perceived growth in their ability to use the resources they had to solve a problem ($t = 2.47$, $p = 0.01$, Hedge's $g = 0.47$) and being creative when there was not much to work with ($t = 3.96$, $p = 0.001$, Hedge's $g = 0.39$), with effect sizes conferring moderate effects (see Table 3). It was not surprising that campers reported improvement on their ability to use limited resources. Twenty-eight campers wrote about an instance during camp when they were faced with not having the resources they desired to complete a task. Because most campers were faced with the reality of limited resources in terms of Lego pieces (either limited to their own kit or to their ability to borrow from others), most talked about a time when they did not have all the resources they needed for their project (five campers stated they did not have any of these kinds of issues). Nearly half of the campers mentioned some kind of improvising as a way to deal with not having all of the resources they wanted. The ways in which they improvised tended to fall into two categories: (1) adapting original idea in order to fit the available resources and (2) maintaining original idea but adapting the resources to accommodate the original plan. While the second type of adaptation seemed to be described in the science notebooks more often, some teams were readily willing to change their ideas to fit what was available for them to use. One camper wrote, "We improvise. We were trying to build a bulldozer, but we couldn't so we built a ramming device instead." On the other hand, some teams maintained commitment to their original ideas and adapted the available resources. For instance, while trying to make an "arm extender," one camper noted, "We couldn't find the right piece. We used a lot of different pieces to do what we wanted." This is an example of sticking with the original idea and improvising with different pieces to get the desired result. Another camper noted their team's ability to do just that: "then we improvise and use different pieces for the same outcome."

Communication. Because the five communication items could not be included in the study as a scale, we assessed each item separately. As seen in Table 3, campers did not indicate a significant perceived increase in communication skills during their camp attendance. The only item that neared significance was "I get along with people" ($t = 1.45$, $p = 0.08$) with a small effect size (Hedge's $g = 0.16$). Analysis of science notebook entries revealed that campers spontaneously mentioned positive and assertive communication as an aspect of being successful in the prompt "letter to a future camper." For example, one camper said, "Make sure you share your ideas! Nothing will get done without them!"

Teamwork. Campers did not report significant growth on the teamwork survey scale ($t = 0.56$, $p = 0.29$, Hedge's $g = 0.11$). In analysis of the teamwork notebook entry, campers tended to express their experiences in terms of their ability to "get along with others" or employ strategies such as "taking turns" – skills and characteristics that campers may have felt they possessed prior to their camp experience, as opposed to gaining these skills during the two- to five-day camps. Regardless, responses to the writing prompts indicated that teamwork was a salient part of the camp experience. Two key elements of teamwork were often reported with expressions of having positive experiences: *feeling included* and *taking turns*. Those who wrote about positive experiences in their science notebooks (having "fun" or "good time" at camp) tended to report feeling included among their teammates, with tangible "jobs" for each member, while those reporting negative or neutral experiences expressed that "most of [their] ideas are not on the robot" or that they or a team member did not have a role. Similarly, positive dynamics observed by facilitators tended to emerge in groups who took turns throughout the building and programming process. This took different forms among teams, such as following the structure of the instruction booklets or organizing an "assembly line" building process. Individual campers who appeared less engaged with their groups tended to report that they "didn't have anything to do" or that they or their ideas were not included.

Furthermore, feeling involved and part of the team impacted other areas of engagement. For instance, science notebook responses suggest differences in persistence when campers do not feel involved in their group. Some participants, particularly those who reported negative or neutral experiences, would "give up" once they had difficulties with teammates or once they did not feel involved. Other times, as suggested by facilitator observations, campers would come back to their group and ask for tasks or take charge of a part of the project on their own. Within the "letter to a future camper" prompt, most campers discussed issues of teamwork, suggesting that experiences with teamwork is important to the overall camp experience. One participant noted that "If you like working alone, you have to learn to work together." Another commented "You should work together so you can have fun."

Enthusiasm for science. In addition to the targeted 4-H life skills discussed above, we were interested in changes in how campers perceived their own enthusiasm for science. Despite only

16 students completing the 18-item enthusiasm for science scale, a significant increase in their perceived enthusiasm for science ($t = 2.03$, $p = 0.03$) was observed with a small but substantial effect (Hedge's $g = 0.28$) as campers averaged a score of 3.35 before the camp and 3.65 afterwards (see Table 3). Facilitator observations and notebook entries further unpacked what kinds of opportunities and interactions might have been specifically connected to this perceived growth in enthusiasm. Facilitators noted that enthusiasm was indicated by a number of actions, communications, and behaviors. Some campers enthusiastically volunteered to assist with different demonstrations, others were so passionate in their discussions with their family members about the camp that parents reported back to facilitators, and some displayed intense and genuine curiosity for robotics, studying all the pieces and practicing how they might fit together to achieve their team goal. Occasionally, facilitators also observed factors that diminished enthusiasm for science among the campers. For instance, some became discouraged by the issues they were having around teamwork while others did not enjoy taking the evaluation surveys or writing in their science notebooks.

When asked if they liked science and/or the camps in the science notebook prompts, most indicated they "like" science (12 of 18), and one respondent said he "loves" science. Most also indicated that they enjoyed the camps. Interestingly, two campers noted that while they were not currently enthusiastic about science, they did like the camps: "I don't really like science, but I like these camps;" "I think science is okay. I like these camps. They're fun." The most common response to what they liked most about the camps was building and programming the robots.

Discussion

This project adds nuance to the existing literature on the impact of participating in summer robotics activities. Survey results supported a small but substantial increase in campers' perceptions of their decision making abilities. Responses to science notebook prompts and facilitator observations highlighted specific processes such as weighing potential options, using trial and error, and asking for help or insight from facilitators or peers. Building on the findings related to decision making, these robotics camps appeared to challenge campers' abilities to use limited resources by creating scenarios where they needed to improvise, adapt existing goals, or adapt how available resources would be used. Despite the lack of significant differences in survey results regarding communication and teamwork, qualitative observations and science notebook entries helped us understand how these skills were involved in much of what campers were doing. Even if campers did not identify growth in these areas, they were practicing and maintaining communication and teamwork skills during the camps. Furthermore, working together and having positive communication were described as ways to increase enjoyment. Finally, a small, but significant perceived increase in enthusiasm for science was observed along with a variety of observed and reflective examples of enthusiasm, suggesting the camps did accomplish their goal of increasing interest and enjoyment with STEM-related activities.

Limitations

We recognize several limitations in the interpretation of our study findings. First, we recognize that programmatic variation across camps introduced bias into the results, weakening the strength of our statistical claims when combining data from all camps. Future research incorporating more camps should attempt to replicate these pilot results. Next, there are noted weaknesses with the post-then pre-survey design utilized in this study, including concerns about accurate recall, social desirability, effort justification, and cognitive dissonance or the feeling that one should have improved (Hill & Betz, 2005). While these weaknesses represent valid concerns for interpreting participants' objective changes in the aforementioned scales, attempts to measure actual growth with a pretest/posttest design in short camps such as these would likely result in response shift bias, a shifting of the metric by which the participant assesses their initial levels of knowledge, skill, or attitudes once they have participated in a program (Howard et al., 1979), and thus may not be a true reflection of any objective change in behaviors, attitudes, or knowledge. Future research incorporating a greater number of camps should explore the impact of camp length on camper outcomes.

Future Directions

Given the growing body of research on rural robotics camps or programs, we present suggestions for future research. First, although not measured in this study, several campers spontaneously discussed the importance of persistence in their letters to future campers, encouraging their successors to persevere and work through frustration and problems that arise. For example, one camper summed up his letter by saying, "The first days are rough, but it gets better. Hang in there." We suggest adding this important variable as a life skill that is potentially enhanced in similar camps. Next, if future researchers seek to model their efforts after our study, we suggest revising the study data collection tools – namely, reducing the number of items on the survey, utilizing a traditional pretest/posttest design (for comparison to the post-then-pre model), and refining the science notebook prompts for brevity and clarity. Furthermore, although we engaged in a good deal of post-session informal debriefing before writing field notes, future studies would ideally follow the model of Williams and colleagues (2007) with more formality. In closing, we believe the next steps in this line of research include applying rigorous, longitudinal designs to test underlying assumptions of the assertion that targeting selected 4-H life skills will enhance the successful application of STEM-related knowledge and skills academically and professionally. This study provides an initial contextual foundation to understand the importance of teaching and studying life skills alongside STEM-related gains.

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Appendix A: Science Notebook Prompts

Decision making:
Think about a choice you made today. You may have had to choose what to do first with your team, or how to build a piece of your robot. Tell us **what choice you had to make** and **how you made your decision.** What did you think about when you made your choice and how do you know it was the right decision?
And
Tell us **what problem you faced** and **what you did when the problem happened.** How were you able to solve the problem?

Use of limited resources:
Sometimes we don't have everything we want to make something, but we keep trying to make it anyway. **What do you and your teammates do** when you don't have all the pieces that you wanted to build with, either because they were not in the box or because you used them already? **Give an example.**

Communication:
4-H involves getting to know a lot of people. Sometimes it is easy to get along and understand others, and other times it is hard. Tell us about a time that **you did not understand** OR **did not get along with another person,** and then tell us **how you responded to that person.** Were you able to get the information you need and get along?

Teamwork:
In 4-H robotics camps, we build robots with other people and there are many roles people have to play. Tell us **how you work with others** at this camp. Do you have your own job in the team? What other jobs do people in your group do? Does this change if you are in a group with different people?

Enthusiasm for science:
People have different thoughts and feelings about science and robotics. Tell us, **do you like science? Do you enjoy these camps?** If so, **what is your favorite part about these camps?** There are no wrong answers, so tell us honestly what you think.

Letter to a future camper:
Now that you have finished working with robots in this camp, you have special knowledge and experience to share with others, like friends and family. Imagine your friend is going to be in this camp next week. **Write a letter** to this friend telling them **what to expect at this camp** and **how to have fun during camp**. Are there problems that come up for everyone, and do you have tips to solve them?

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