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IMPLEMENTATION AND EVALUATION OF A NUTRITON-FOCUSED STEAM SUMMER PROGRAM FOR URBAN YOUTH

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IMPLEMENTATION AND EVALUATION OF A NUTRITON-FOCUSED STEAM SUMMER PROGRAM FOR URBAN YOUTH

BY

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ABSTRACT

Background: Youth from low-income, racially and ethnically diverse families are at increased risk for academic challenges and nutritionally inadequate diets. Summer programs offer an opportunity to foster interest and engage students in science, technology, engineering, art, and math (STEAM) education while addressing summer learning loss. Nutrition education early in life can help youth develop healthy dietary behaviors that they carry into adulthood. Project stRIde: Science and Technology Reinforced by Innovative Dietary Education was a summer program for 4-6th grade youth from racially and ethnically diverse and low-income families. The goal of the program was to engage youth in nutrition-centered STEAM education to mitigate summer learning loss and promote healthy dietary behaviors.

Objectives: The objectives of this study were to 1) describe curriculum development, revisions, and preliminary pilot findings in the two developmental years of Project stRIde, 2) describe Design-Based Implementation Research (DBIR) using examples from Project stRIde for use as a guide for other practitioners, and 3) examine the effectiveness of Project stRIde including interest and choice in STEAM, intended behavior changes, program acceptability, appropriateness, feasibility, and overall program impact.

Methods: Project stRIde was delivered over three summers to community partner summer camp sites in urban, low-income areas of Rhode Island. DBIR was leveraged throughout the program to develop the curriculum and make collaborative edits after each year. A team of community partners, youth participants, program staff, and researchers were consulted for this study. In the first two developmental years, participant post-lesson knowledge (PLK) questions, interviews with camp staff, dose delivered, reach, and

fidelity were used as process measures. Exploratory outcomes included pre/post participant attitudes towards STEAM (S-STEM Survey) and self-efficacy for asking for fruits and vegetables (ASKFV-SE) through previously validated surveys. The pre/post scores from both surveys were compared using paired *t*-tests with a significance value of $p<0.05$. In the third year of programming, a pre/post-test design was used to measure student interest and choice in STEAM (SIC-STEM Survey). Camp staff completed an acceptability of intervention, intervention appropriateness, and feasibility of intervention measure (AIM, IAM, FIM) post-intervention. Interviews were conducted post-intervention with youth participants and staff to assess STEAM and nutrition knowledge gained, intended behavior changes, acceptability, and overall program impact.

Results: Project stRIde successfully reached a racially and ethnically diverse population, had high fidelity (>80%), and over 60% of participants attended 4 or more out of six total lessons each year. In the developmental years, low scoring lessons as indicated from the PLK questions were edited or omitted from the final program model. Main ideas summarized from interviews included appropriateness of content, program acceptability, student engagement, and sustainability. There were no changes in pre/post attitudes towards STEAM or self-efficacy for asking for fruits and vegetables. The team decided to add more hands-on activities, simplified lesson concepts and activities, and creative evaluation strategies with youth. In the third year, the final program model was delivered. Themes from camp and program staff interviews include program acceptability, positive impact on STEAM and nutrition knowledge, program model was simplified and guided by youth choice, summer camp setting was a barrier, and perceived impact on participant

engagement and enjoyment. There were no significant changes in pre- to post-SIC-STEM survey scores. Camp staff rated Project stRIde as acceptable, appropriate, and feasible. **Conclusions:** Youth PLK questions, dose, fidelity, reach, and interviews with camp staff served as valuable process measures when evaluating Project stRIde's developmental years. In its final program model, Project stRIde was rated as acceptable, engaging, and shows promise in mitigating learning loss among at-risk youth. Overall, DBIR served as a valuable model for creating yearly edits to the curriculum and landing on a final program model. It was a useful strategy for identifying problems, developing the curriculum, and organizing the iterative process. Similar outreach programs should consider DBIR when designing and implementing programs. Future directions for Project stRIde include adapting this program for other settings and working with community partners to promote program sustainability.

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PREFACE

This dissertation was prepared according to the University of Rhode Island Graduate School manuscript format. Manuscript #1 was prepared following the guidelines for submission to **Implementation Science.** Manuscript #2 was prepared following the guidelines for submission to the **Journal of Extension.** Manuscript #3 was prepared following the guidelines for submission to the **Journal of Nutrition Education and Behavior.** Upon submitting this dissertation to the Graduate School, the manuscripts may be submitted for publication.

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CHAPTER 1

MANUSCRIPT

This manuscript was prepared in accordance with author guidelines for Implementation Science. It is currently in preparation for submission.

Title: Development, Revisions, and Preliminary Findings of a Nutrition-Focused STEAM Curriculum for Urban Youth

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ABSTRACT

Background: Project stRIde: Science and Technology Reinforced by Innovative Dietary Education was a summer program for youth from racially and ethnically diverse and low-income families. The goal of the program was to engage youth in nutrition-centered STEAM (science, engineering, technology, arts, and mathematics) education to mitigate summer learning loss and adverse dietary behaviors. Design based implementation research (DBIR) was leveraged to effectively develop, deliver, and evaluate the program.

Methods: Project stRIde was piloted once a week for six weeks over two consecutive summers at summer camp sites. Participant post-lesson knowledge (PLK) questions, interviews with camp staff, dose delivered, reach, and fidelity were used as process measures. PLK questions were expressed as a percent correct. Main ideas from interviews at the end of each summer were summarized. Exploratory outcomes included pre/post participant attitudes towards STEAM and self-efficacy for asking for fruits and vegetables through previously validated surveys. The pre/post scores from both surveys were compared using paired *t*-tests with a significance value of $p<0.05$.

Results: Project stRIde reached a racially and ethnically diverse population and fidelity was high (>80%) across both years. Approximately 66% of participants in year 1 and 68% of participants in year 2 attended 4 or more lessons. Low scoring lessons as indicated from the PLK questions were edited or omitted for the final program model. Main ideas summarized from interviews included appropriateness of content, program acceptability, student engagement, and sustainability. There were no changes in pre/post attitudes towards STEAM or self-efficacy for asking for fruits and vegetables. Edits made

to the curriculum include more hands-on activities, less concepts per lesson, and more creative evaluation strategies with youth.

Conclusions: Post-lesson knowledge questions, dose, fidelity, reach, and interviews with camp staff served as valuable process measures when evaluating the implementation of Project stRIde. DBIR served as a value model for creating yearly edits to the program and landing on a final program model.

BACKGROUND

Youth from low-income families and racially and ethnically diverse backgrounds are at higher risk for health and academic achievement disparities.(1-4) Children across all socioeconomic strata in the United States (US) are failing to meet standards set by the Dietary Guidelines for Americans (DGAs), but even more so in youth from lower socioeconomic status (SES) families.(1,5,6) Dietary patterns in low SES youth are substantially worse than those from higher SES families.(6,7) This is due to lack of healthy food access, food cost, and lack of access to nutrition education.(8,9) Prolonged poor dietary habits are associated with the development of chronic diseases such as cardiovascular disease (CVD) and type 2 diabetes.(10) Racially and ethnically diverse populations are disproportionately affected by chronic disease.(11) Hispanic and non-Hispanic Black children have the highest rates of obesity in Rhode Island (RI) and nationally, which is a risk factor for many chronic diseases.(12) As a result, racial and ethnic minority groups experience earlier onset of illness and more severe diseases at all stages of life, including pre-adolescence.(13,14)

In addition to health disparities, youth from low-income families are at risk for decreased academic achievement, which has been further exacerbated by the COVID-19 pandemic.(3,4) Standardized test scores decreased nationally in the years following the pandemic, and the largest decrease was seen in schools serving students who live in low-income communities.(3) Standardized test data from the Rhode Island Comprehensive Assessment System (RICAS) and Next Generation Science Assessment highlight these disparities among Rhode Island youth.(15) Fifth grade students from RI's core cities,

cities that have at least 25% of children living below the poverty threshold, score markedly lower on these exams than RI 5th grade students as a whole.(15)

Summer learning loss, the loss of information gained over the school year during summer vacation, impacts all school-aged youth.(16) Learning loss ranges are largely variable, ranging from one to three months of loss in math.(16) Experts suggest implementing summer programs to reinforce information learned over the school year targeted to students who may have fallen behind.(16,17) Programs held outside of school time (OST) offer a chance to address gaps in summer learning, particularly for youth from low-income and racially and ethnically diverse families who are in the greatest need for supplemental instruction.(17) Experts suggest implementing innovative, educational, OST programs to address the detrimental effects of summer learning loss and the pandemic on youth learning.(16,17)

Design-Based Implementation Research (DBIR) was leveraged by Project stRIde: Science and Technology Reinforced by Innovative Dietary Education to effectively develop, deliver, and evaluate the program. DBIR focuses on developing and implementing effective, scalable, and sustainable programs.[19,20] In DBIR, several key personnel such as educators, community partners, and researchers come together to identify problems in program delivery.[19] DBIR is often used in iterative program designs, such as curriculum development.[21] The approach is especially relevant to this project because of the evolving nature of program development and collaboration with community partners.[10,11]

Project stRIde is a six-week OST program designed to address academic and health disparities faced by RI urban youth from low-income families. It aims to excite

and educate young people about science, technology, engineering, art, math (STEAM), and nutrition. The Project stRIde curriculum previously underwent a formative evaluation with a review panel of experts in nutrition, STEAM, education, and summer programming.[18] Afterwards, revisions to the curriculum were made and the program was piloted.[18]

The overall goal of this study was to apply DBIR to explain collaborative decisions and evaluation, and to provide a framework for the developmental years of programming. Originally designed as a summer camp program, Project stRIde was delivered between July and August in 2021 and 2022. The first two years of Project stRIde were developmental years, in which edits were frequently made to improve program delivery and the overall curriculum. Edits were made in close collaboration with community patterns, educators, and researchers. The outcomes of this process will be described according to the four DBIR principals: 1) focus on persistent problems of practice from multiple perspectives, 2) commit to iterative, collaborative design, 3) develop theory and knowledge related to learning and implementation through systematic inquiry, and 4) develop capacity for sustaining change.(18)

METHODS

This study describes Project stRIde through its first two developmental years. This included two cohorts of 4th-7th grade students and resulted in a final program model implemented during Summer 2023. A process evaluation was conducted with participants and camp staff to formally identify strengths, weaknesses, and opportunities for program improvement over the two years. Exploratory outcomes such as attitudes towards

STEAM subjects and self-efficacy for asking for fruits and vegetables were evaluated pre- and post-intervention with the students.

Intervention

The following study used a community-driven approach to develop and evaluate Project stRIde. The curriculum contained five, one-hour lessons that integrated STEAM concepts with nutrition education. The curriculum was designed to align with the U.S. Common Core, Next Generation Science, and Rhode Island Health Framework Standards for fifth and sixth grade students.(19-21) Each week provided hands-on, innovative lessons focused on a different topic within STEAM and nutrition. For example, participants practiced math by calculating the amount of sugar in one bottle of soda consumed over one week, one month, and one year. Instructors then used this information to facilitate a discussion on healthy beverage choices.

Project stRIde was intentionally implemented through different delivery styles due to the iterative DBIR process and feedback from community partners. Collaborative changes were made between the two developmental years and again after year 2 to result in a final program model (year 3). Similarities and differences among all years are outlined in **Table 4**.

Sample & Data Collection

Multiple perspectives were used throughout this study to align with the first principle of DBIR, including youth program participants and camp staff. Youth participants attended either year 1 or year 2 of Project stRIde programming. Participants were primarily in 4-7th grades and attended one of three summer camps in RI. The summer camps were located in urban areas and primarily served low-income

communities. Camp staff that observed Project stRIde or held management positions at one of the three delivery sites during year 1 or 2 were included in this study.

Data Collection

Youth Process Measures

Project stRIde participants completed post-lesson STEAM and nutrition concept knowledge questions at the end of each lesson in years 1 and 2 as process measures to ensure main objectives of the lessons were adequately delivered. These post-lesson questions consisted of 2-3 brief, written, multiple choice questions about the main ideas covered in the corresponding lessons. Dose received was documented both years 1 and 2 across all sites through attendance sheets. Reach of the program was collected using a 6-item demographic questionnaire. Fidelity was documented using fidelity checklists adapted from a SNAP-Ed program, *Students Take Charge!*, and completed by one non-instructor member of the program staff.

Youth Exploratory Outcome Measures

Measures that addressed attitudes towards STEAM and self-efficacy in asking for fruits and vegetables were explored across the two years of program development. Participants completed an Attitudes Towards STEAM and Asking for Fruit and Vegetable Self-Efficacy (ASKFV-SE) measure at pre- and post-intervention. The Attitudes Towards STEAM survey was adapted from a previously validated survey in this age group.(22) It was a 26-item questionnaire originally designed to assess students' attitudes towards STEAM subjects and their interest in STEAM careers.(22) In year 1, the full survey was delivered. In year 2, a shortened, 6-item version of this survey was used to assess attitudes towards STEAM subjects only due to participant fatigue from the

previous year. The ASKFV-SE measure also went through psychometric evaluation with a low-income, racially and ethnically diverse population and was identified as valid and appropriate for this population.(23) The original survey consisted of seven items, five in the home setting, two in the school setting.(23) Due to the nature of the program, only the five questions relating to youth fruit and vegetable choice in the home were used.

Camp Staff Process Measures

This study analyzed camp staff evaluations of Project stRIde to further expand on youth outcomes. Informal, semi-structured interviews with camp staff were conducted to better understand their perceptions of Project stRIde and its revisions over the developmental years. These virtual interviews were held at the conclusion of summer programming with 1-2 members of the research team. Camp staff were asked about their thoughts on Project stRIde, challenges and/or successes to implementation, and changes they would like to see in future years. Interviewees were individuals with varying levels of leadership positions, ranging from camp counselor to camp director to achieve a multi-level perspective. To assist in comparing the acceptability, appropriateness, and feasibility of Project stRIde after the first developmental year, camp staff completed the Acceptability of Implementation (AIM), Intervention Appropriateness (IAM), and Feasibility of Intervention Measure (FIM) post-intervention in year 2. The three measures were given together at the culmination of the program, consisting of 12 items in total.(24)

Data Analysis

Data analysis in this study aims to achieve the fourth DBIR principle, developing theory and knowledge related to implementation through systematic inquiry.[22,29] It is

important to allow for quick data analysis in DBIR so that edits may be made to the program before the next time it is delivered. Thus, qualitative and quantitative data analyses were completed by a member of the research team and findings were regularly discussed with program and camp staff throughout program development and implementation.(25) The post-lesson knowledge assessment questions for each lesson were expressed as a percentage correct and used as process measures to indicate lessons that needed improvement. Several questions were edited across developmental years 1 and 2 to reflect changes to the program and were thus analyzed separately for each cohort of students. Dose, reach, and fidelity were compared between sites as process evaluation data using attendance sheets, demographic questionnaires, and fidelity checklists, respectively. The pre-post scores from the Attitudes Towards STEAM and ASKFV-SE surveys for Years 1 and 2 were compared using paired *t*-tests with a significance value set at $p<0.05$.

For camp staff outcomes, in-depth notes were taken by one member of the research team during interviews and compiled after each year. Scores from the AIM, IAM, and FIM were summarized with higher scores indicating greater acceptability, appropriateness, and feasibility.(26) These scores along with major themes from interviews were used to describe the overall revisions and developments made to the curriculum in future years.

RESULTS

Youth and Camp Staff Demographics

Project stRIde reached 88 youth participants over the two developmental years of programming. Participants ranged from grades 4-8 and primarily identified as Black

(51.1%) or more than once race (19.3%). Full demographic information is available in **Table 1**. Camp staff (*n*=15*)* were either camp counselors, summer program directors, or camp directors with varying years of experience.

Youth Process and Outcome Measure Results

Approximately 66% of participants in year 1 and 68% of participants in year 2 attended 4 or more lessons. Checklists reported fidelity of 80% or higher across all lessons in the two years.

Data from the post-lesson questions are available in **Figure 2**. Responses for post-lesson questions were comparable between the two years. It is important to note that lesson order changed across the two years. The lowest scoring lessons in both years 1 and 2 were Fat Needs and Fast Food Choices (44% and 63% correct, respectively). The highest scoring lessons across both years were Lesson 1: Fruits and Veggies, the Environment, and Me (87% and 92% correct, respectively). Youth disliked answering the post-lesson questions. Several complained of feelings of being "tested" and stress of getting answers right while others circled answers without reading questions at all.

This study used a pre-post design to measure attitudes towards STEAM and self-efficacy for asking for fruit and vegetables. While both surveys were used in each developmental year, the STEAM survey was shortened from 26 items in year 1 to six items in year 2. After discussing with camp staff, program staff, and participant feedback during the program, surveys were identified as a major drawback to the program. The STEAM survey was shortened to reduce participant fatigue. However, even with the shortened survey in year 2, participants still protested the surveys. No significant changes were seen in either survey from pre- to post-intervention.

Camp Staff Process Measure Results

At the end of each summer, camp staff were interviewed by members of the research team. The main ideas from the interviews are summarized in **Table 2**.

Year 1

In year 1, camp staff (n= 6) at both sites commented on the appropriateness of nutrition education and STEAM topics. Staff discussed the importance of introducing nutrition education topics as seen in the Appropriateness of Content section in **Table 2**. Both sites stated that Project stRIde fit into STEAM educational standards set by the Boys and Girls Clubs and/or the corresponding school districts.

Staff also admired the hands-on, engaging nature of the lessons. However, camp staff agreed that the educational videos shown each week were long and did not engage students due to the previous year of receiving virtual education. Instead, the research team suggested turning these videos into age-appropriate books to be read as a class. Staff endorsed this idea, stating that books may be more engaging and easier to focus on than videos.

The original goal of this program was to train camp counselors to deliver Project stRIde after year 1. Therefore, camp staff was asked questions about training needs and processes for year 2. Ultimately, camp staff discussed high camp counselor turnover rates as seen in the Sustainability section of **Table 2**. Staff agreed that training a more permanent staff member would be helpful. While camp counselors have 2-3 days of training before camp begins each summer, the days are very full, camps are often short on staff, or staff don't begin working until after the training. Other suggestions included

more time for team building activities and more opportunities for student choice throughout lessons. Camp staff did not complete the AIM, FIM, IAM measure in year 1.

Year 2

In year 2, camp staff (*n*=3) completed end-of-program interviews and the AIM, FIM, and IAM (*n*=6). In this second developmental year, Project stRIde staff worked closely with a counselor at one of the three sites to co-lead the program. The counselor was given the lessons in advance and asked to help lead the program with the support of another nutrition educator to move towards the train-the-trainer model originally planned for this grant.

Staff feedback from interviews regarding their overall thoughts and impressions was comparable to year 1. Staff enjoyed the messaging and values of the program, with one counselor noting the important health implications of the content. Staff added that youth participants enjoyed and were engaged in art and engineering projects. Though the creation of books was suggested after year 1, some camp staff did not believe the books were age-appropriate, stating they were "*too slow and easy.*"

When sharing thoughts on incorporating more youth-led, team building activities into the programs, camp staff discussed the importance of trust and relationship building with youth. Staff agreed that it is important to give youth a choice in activities or what they want to spend more time on.

One of the original goals of the program was to provide stand alone activities that youth could lead and participate on their own time. However, camp staff disliked this idea due to issues with power dynamics between students. Camp staff discussed social difficulties with students leading other students in activities. It would not be guaranteed

that youth would complete these activities on their own. Staff added that engagement is increased when community partners teach lessons. Students are more receptive and enjoy the change of pace. At the train-the-trainer model site, the counselor believed he would feel more comfortable teaching one specific activity instead of teaching an entire lesson.

Mean scores from the AIM, IAM, and FIM measures were evaluated across all three sites. Though no precise cutoffs have been established, all mean scores were above average (**Table 3**). The FIM scored the highest, with respondents selecting either "agree" or "completely agree" for each question. *Project stRIde seems doable* and *Project stRIde seems applicable* were the highest-scoring individual questions. *Project stRIde seems fitting* and *Project stRIde seems like a good match* were the lowest scoring questions.

DISCUSSION

Challenges to program implementation

Overall, this study used feedback from youth participants, camp staff, and the research team to identify challenges, successes, and ultimately create a final Project stRIde program model to be implemented in year 3. Although an overall successful program, several challenges to program implementation arose during Project stRIde's formative years. Data collection, camp staff facilitation of the program, and the setting were collaboratively identified as challenges. Data collection was a primary issue throughout the program because of the length, format, and wording of available surveys. Three CYFAR grant surveys were required in addition to the Attitudes Towards STEAM and ASKFV-SE surveys. Students spent over 20 minutes working through all of the surveys. Although the Attitudes Towards STEAM survey was shortened, participants and camp staff continued to dislike the surveys. It was difficult to capture participants'

attention with paper and pencil surveys in the summer camp setting. The research team combed the literature to search for applicable STEAM measures but many were inappropriate for this age group in length and reading comprehension. There is a lack of validated surveys assessing youth perceptions of STEAM and a need for more engaging methods of data collection.

The post-lesson questions participants completed each week were beneficial for edits to the curriculum although they were generally disliked by participants. The literature surrounding youth data collection shows that participants are less likely to supply complete and accurate responses to longer surveys.(27) Camp and program staff hypothesize that the summer camp setting exacerbates survey fatigue as students do not want to complete paperwork in any capacity. Students view summer camp as a fun environment and an academic break. Moving forward, more innovative methods of data collection with participants should be used. In the final program year, interviews with students are planned in place of post-lesson questions to decrease the amount of paper surveys.

Another challenge to the program design over the developmental years was the issue of program leadership. The goal of the grant was for the program to be completely self-sustaining by the culmination of the grant period to address the final DBIR principle, capacity for sustaining change in systems.(18) This included camp counselors being trained on and leading the lessons themselves. The research team found that this would not be feasible after interviews with camp staff and attempting a train-the-trainer model in year 2. Program staff provided training and technical support. However, the camp staff member cited lack of time to prepare for lessons and lack of confidence in teaching

nutrition-focused lessons as major barriers to facilitating the program. In turn, program staff taught most lessons. This barrier is not unique to Project stRIde. Teachers commented similarly in one study in which researchers attempted to train them on a nutrition and physical activity curriculum.(28,29) Two main barriers to program delivery by teachers were unwillingness of teachers to learn curriculum and the training process itself.(28,29) Teachers, like camp staff, have many other responsibilities in a day and training on a new curriculum can be time consuming.(28,29) In addition, camp staff discussed how effective outside community partners are in delivering programs compared to camp staff. They stated youth are more likely to be engaged with community partners. In one study, teachers commented on the importance of maintaining contact with outside experts for support.(28) It was determined that the program should pivot to program staff delivery in year 3.

Along with staffing, the summer camp setting presented as a challenge in curriculum delivery. Program staff struggled to keep youth engaged during STEAM lessons. This was most likely due to the physical summer camp environment and the less structured format of summer camp. Youth in these camps usually have choices of fun activities such as swimming, playing games, or using technology. Project stRIde required youth to come together for somewhat classroom-style learning. More hands-on, youth-led activities were added to the curriculum to address these issues. Though the program aims to decrease the summer learning gap in STEAM subjects, this program may be more well suited for an after-school setting.

Successes of program implementation

The major success of this program was its use of DBIR to make collaborative edits to the curriculum in the developmental years and moving forward. Post-lesson questions, fidelity checklists, camp staff interviews, and the acceptability, appropriateness, and feasibility measure allowed program staff to create edits between and after the developmental years of the program. Low-scoring lessons on the post-lesson questions were edited to incorporate different activities, teaching strategies, or removed altogether. For example, the Fat Needs and Fast Food Choices lesson was a low-scoring lesson throughout both years. For the final program model, this lesson will be made more age-appropriate with a focus on the heart instead of chemical bonds. Fidelity was high throughout both years, but it became evident throughout the program that students were being overloaded with information during year 1. Students were unable to focus on activities that they enjoyed and the program often ran over its allotted time. In year 2, the program was simplified to include only one STEAM and one nutrition education lesson per week. However, this issue persisted in year 2. In the final program model, the program will deliver one STEAM or nutrition lesson each week, with the focus on hands-on activities instead of lesson delivery by facilitators. Program staff were able to make other edits such as staff delivery, evaluation approach, and mode of delivery through these process measures. These types of edits are common in DBIR studies. In one after-school STEM program for Latina girls, researchers analyzed several types of data including interviews, surveys, and observations to inform program changes.(30) The study identified positive changes to the curriculum such as integrating writing into science and art projects, more opportunities for small group work, and using youth-centered language.(30) DBIR is also useful in the development of curricula. In a study of

the development of a chemistry curriculum for educators, community partners and teachers were interviewed.(31) Researchers were able to collect mixed-methods data and collaborate with community partners to create a well-rounded curriculum.(31)

Another strength of this program was its ability to align with Common Core and Next Generation Science Standards (NGSS) and reach its intended audience.(19,20) The expert content review of the curriculum prior to year 1 programming ensured the curriculum met standards for this age group while simultaneously accounting for academic achievement gaps that exist in underserved areas.(32,33) All curriculum edits were designed with these standards in mind. The program originally intended to reach a low-income, racially and ethnically diverse population in core cities of RI. **Table 1** shows this population was reached and the program was delivered to those historically at risk for academic and health disparities.

Future directions

DBIR allowed for continuous, collaborative revisions to Project stRIde and similar programs. The final program model will be delivered in year 3 of the grant. This model will be facilitated by program staff at three community partner sites during the summer. Each week will contain one STEAM or nutrition education lesson. Evaluation approaches will be edited to better suit the needs of participants. The curriculum will contain more team building, hands-on, and youth-led activities. Lastly, the program will use kits to enhance the sustainability of the program. These kits were inspired by the 4-H model, which offers STEM kits to local community partners. Kits include simple directions for educational activities that can be led by youth or adults without a STEM

background. Project stRIde hopes to emulate this model to provide STEAM and nutrition education to community partner sites in the future.

CONCLUSION

Overall, DBIR provided a unique model for developing an OST nutrition-centered STEAM program. Post-lesson knowledge questions, dose, fidelity, reach, and interviews with camp staff served as valuable process measures when evaluating the implementation of Project stRIde. Fidelity was high across the two years and the program successfully reached its intended audience, most of which attended four or more lessons. Camp staff commented on the importance of the subject matter and offered edits to further improve the curriculum in future years. In addition, they rated Project stRIde acceptable, appropriate, and feasible. Project stRIde has evolved to a final program model which includes more hands-on and team building activities, less concepts per lesson, and more creative evaluation strategies with youth. DBIR will continue to serve as a beneficial strategy to creating curriculum edits in the future years of the grant and beyond.

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TABLES

Table 1: Demographic Characteristics of Participants in Developmental Years

	n	**Percentage (%)**
Total Participants	88	
Gender		
Male	50	56.8
Female	37	42.0
Grade		
4	8	9.0
5	30	34.0
6	30	34.0
7	16	18.0
8	3	3.4
Ethnicity		
Hispanic or Latino	32	36.4
Race		
Asian	0	0.0
Black or African American	45	51.1
White	14	15.9
Other	6	6.8
More than one race	17	19.3

Table 2. Themes from Camp Staff Virtual Interviews at the End of Program Years 1 and 2

Main Themes	Year 1	Year 2
	Quotes	**Quotes**
Appropriateness of Content	*"Project StRIde fits in well with the American Camping Association certification held by Boys and Girls Club."*	*"The program gave children nutritional knowledge that they aren't necessarily learning in school."* *"The books were too slow and easy."*
Program Acceptability	*"The program was well structured."* *"It was helpful that the children were able to create and build rather than just sitting while learning."*	*"I liked the message that its teaching kids to eat right and take care of their body overall because a lot of kids don't know what foods are good and what they do for their body."* *"The message, values [staying healthy] are beneficial. It's a difficult topic for engagement but super important for their life."*
Student Engagement	*"The beginning had less enthusiasm and some resistance but there was more excitement as the routine built."* *"Videos were difficult for the kids to focus on."*	*"More fun activities would be great. This pod loves structured activity."* *"Student choice is really important."* *"During readings some kids didn't want to participate but more kids were vocal during the hands-on and art components of the program."*
Sustainability	*"We only keep about 50% of counselors per summer."* *"There is not a lot of time [for training] due to when school ends and camp begins."*	*"I do not recommend having kids do kits without an adult more closely involved. Kids controlling other kids is a difficult situation without basic structure and basic rules."* *"When other providers come in, the kids are more receptive and love the change of pace."*

Table 3. Acceptability of Implementation (AIM), Intervention Appropriateness (IAM), and Feasibility of Intervention Measure (FIM) Results from Camp Staff Participants in Year 2. Measures are scored on a scale of 1- Completely Disagree, 2- Disagree, 3- Neither Disagree nor Agree, 4- Agree, and 5- Completely Agree. Camp staff participants are represented by P1-6.

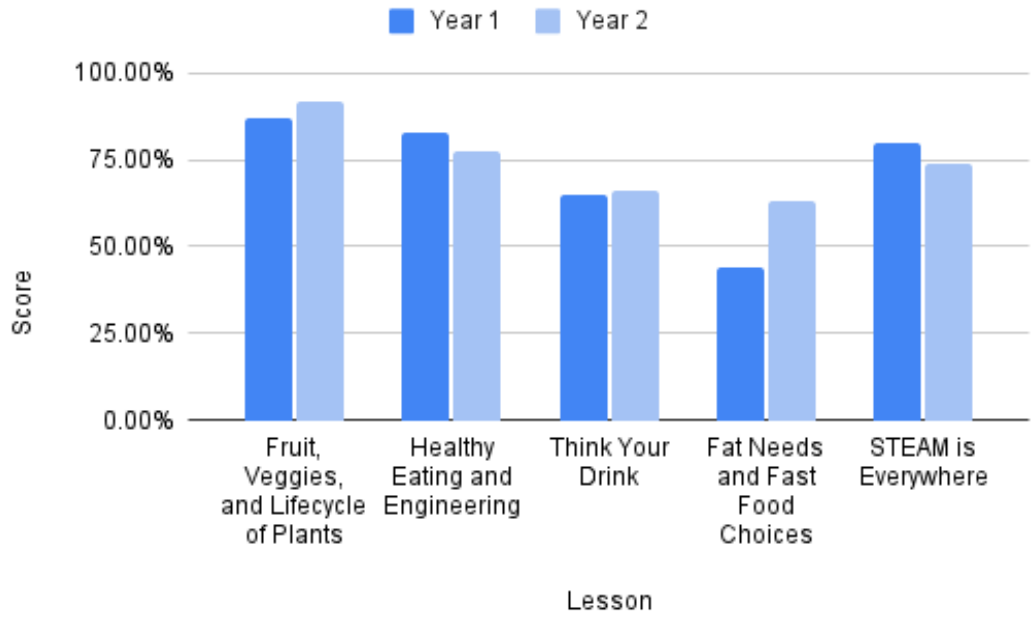
Acceptability of Implementation Measure (AIM)	**P1**	**P2**	**P3**	**P4**	**P5**	**P6**	**Mean Score**
1. Project stRIde meets my approval.	2.00	2.00	4.00	5.00	5.00	5.00	3.83
2. Project stRIde is appealing to me.	4.00	4.00	5.00	5.00	4.00	4.00	4.33
3. I like Project stRide.	3.00	3.00	4.00	5.00	4.00	4.00	3.83
4. I welcome Project stRIde.	4.00	4.00	4.00	5.00	5.00	5.00	4.50
AIM Mean (SD)							**4.13 (0.95)**
Implementation Acceptability Measure (IAM)	**P1**	**P2**	**P3**	**P4**	**P5**	**P6**	**Mean Score**
1. Project stRIde seems fitting.	2.00	2.00	4.00	5.00	4.00	5.00	3.67
2. Project stRIde seems suitable.	2.00	2.00	5.00	5.00	4.00	5.00	3.83
3. Project stRIde seems applicable.	4.00	4.00	5.00	5.00	5.00	5.00	4.67
4. Project stRIde seems like a good match.	2.00	2.00	4.00	5.00	4.00	5.00	3.67
IAM Mean (SD)							**3.96 (1.23)**
Feasibility of Implementation Measure (FIM)	**P1**	**P2**	**P3**	**P4**	**P5**	**P6**	**Mean Score**
1. Project stRIde seems implementable.	4.00	4.00	4.00	5.00	4.00	4.00	4.17
2. Project stRIde seems possible.	4.00	4.00	5.00	5.00	5.00	4.00	4.50
3. Project stRIde seems doable.	4.00	4.00	5.00	5.00	5.00	5.00	4.67
4. Project stRIde seems easy to use.	4.00	4.00	4.00	5.00	5.00	5.00	4.50
FIM Mean (SD)							**4.56 (0.51)**

Table 4. Comparison of Project stRIde Program Delivery Styles Years 1-3

	# of sites	*Program Development Phase*	*Staff Delivery*	*Integration of STEAM and Nutrition*	*Evaluation Approach*	*Mode of Delivery*	*Sustainability Plan*	*Intended Settings*
Year 1	2	Developmental	Program staff	1-2 STEAM, 1-2 nutrition concept each lesson	Youth exploratory outcome measures and process measures, Camp staff process measures	Hybrid: Videos, teaching-focused, paper & pencil activities	Transition from program staff to entirely camp staff led	Summer, community partner sites
Year 2	3	Developmental	Program and camp staff	1 STEAM, 1 nutrition concept each lesson	Youth exploratory outcome measures and process measures, Camp staff process measures	In-Person: Books and kits, teaching-focused with some hands-on activities	Transition from program staff to entirely camp staff led	Summer, community partner sites
Year 3	3	Final program model	Program staff	Either 1 STEAM or 1 nutrition concept per lesson	Youth exploratory outcome measures and youth interviews, Camp staff process measures	In-Person: Books and kits, youth-focused curriculum, more hands-on activities	Standalone "kits" with nutrition-centered STEAM activities for a variety of settings, ages, groups sizes	Summer, other school vacations, after-school, community partner sites, libraries

FIGURES

Figure 1: Post Lesson Knowledge Assessment Scores for Participants in Years 1 and 2 of Project stRIde



CHAPTER 2

MANUSCRIPT

This manuscript was prepared in accordance with author guidelines for the Journal of Extension as a Tools of the Trade article. It is currently in preparation for submission.

Title: Incorporating the Design-Based Implementation Research Principles into Youth Outreach Programming

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ABSTRACT

Design-based implementation research (DBIR) is guided by four main principles which provide a model for collaborative implementation research. DBIR is commonly implemented in formal, academic settings with researchers, teachers, community members, and/or students joining together to form a partnership. However, evidence suggests this strategy may also be useful in youth outreach programming. This paper explains the four principles of DBIR and how they helped guide Project stRIde: Science and Technology Reinforced by Innovative Dietary Education, a summer program for youth from low-income families. We provide a guide for practitioners implementing programs similar to Project stRIde through DBIR.

Introduction:

Community-engaged research (CEnR) describes collaborative work with community partners, researchers, and educators to address inequities in a specified audience (Goodman & Sanders Thompson, 2017; Luger, Hamilton, & True, 2020; Wallerstein, Nina et al., 2020). Involving community partners in research design can result in interventions that are better targeted to the needs of the community and therefore more engaging and readily accepted by participants (Luger, Hamilton, & True, 2020; Wallerstein, Nina & Duran, 2006). This can also build trust and respect between researchers and community partners, especially in historically underserved communities (Esmail, Moore, & Rein, 2015; Luger, Hamilton, & True, 2020; Wallerstein, Nina B. & Duran, 2006). Design-based implementation research (DBIR) uses these principles to explore the design and implementation process in curriculum development (Fishman & Penuel, 2018; LeMahieu, Nordstrum, & Potvin, 2017). Studies show DBIR is useful in designing curricula, improving student educational outcomes, and solving specific problems faced by a community (Fishman & Penuel, 2018; Stosich, Bocala, & Forman, 2018; Underwood & Kararo, 2021). It is guided by four main principles: 1) focus on persistent problems from multiple perspectives, 2) commit to iterative, collaborative design, 3) develop theory and knowledge related to learning and implementation through systematic inquiry, and 4) develop capacity for sustaining change (Fishman & Penuel, 2018). DBIR is less commonly used in Extension settings such as the development of outreach programs (Nation, Harlow, Arya, & Longtin, 2019; Subramaniam, Hoffman, Davis, & Pitt, 2021). The development of Project stRIde: Science and Technology Reinforced by Innovative Dietary Education over the last five years demonstrates how

DBIR can be incorporated into curriculum revisions, materials, and other implementation needs (Nation, Harlow, Arya, & Longtin, 2019; Subramaniam, Hoffman, Davis, & Pitt, 2021). This paper describes the four DBIR principles and incorporates examples from the outreach program to provide a guide for future practitioners.

Program Overview

Project stRIde was created as part of a United States Department of Agriculture (USDA) Children, Youth, and Families at Risk (CYFAR) grant. The program ran for three summers in community partner summer camps in urban areas of Rhode Island. The overall goal of the program was to excite and engage youth in science, technology, engineering, arts, and mathematics (STEAM) activities while simultaneously providing nutrition education concepts. The curriculum contained six, one-hour, hands-on lessons over six weeks designed to align with national education standards for fifth and sixth grade students. Participants primarily identified as Black and about a third of participants were Hispanic. Over half of students in these communities qualified for free or reduced-price lunches (FRPL) (RIDE report card, 2019).

Focus on Persistent Problems from Multiple Perspectives

Creation of an interdisciplinary, collaborative team is the first step in DBIR. Teams should consist of key personnel from a variety of backgrounds (Fishman & Penuel, 2018). Teachers, researchers, students/participants, and community leaders are often included in these teams (Fishman & Penuel, 2018). Individuals with multiple perspectives can better identify problems within the specific communities they belong to (Fishman & Penuel, 2018; McKay, 2017). This team should collaborate on how the problem can be addressed, what can be done, and the best approaches to take to resolve

or mitigate the problem (Fishman & Penuel, 2018; LeMahieu, Nordstrum, & Potvin, 2017). Discussions amongst the team about program goals, strengths, and weaknesses should continue for the length of development and implementation, which is further described by the second DBIR principle.

Project stRIde emulated this first principle by beginning with a thorough needs assessment. An expert panel of researchers, education professionals, nutrition professionals, and summer camp leadership was consulted to inform the development of the Project stRIde curriculum (Potvin et al., 2023). The goal of this panel was to ensure that the curriculum addressed issues facing youth in this community, mainly summer learning loss and adverse dietary behaviors (Potvin et al., 2023). Collaboration with this team allowed program staff to understand the unique inequities and problems faced by a racially and ethnically diverse, low-income population.

Commit to Iterative, Collaborative Design

A commitment to iterative, collaborative program design guarantees continuous improvement through feedback garnered from team members. The goal of establishing the design process is to improve teaching tools, such as a lesson curriculum, and the implementation of the tools (Fishman & Penuel, 2018). The process of iteration, specifics of team meeting and collaboration, and decision of how program changes will be made are all critical factors of DBIR that fall under this principle (Fishman & Penuel, 2018; McKay, 2017).

The use of process measures is beneficial to addressing these factors. Process measures such as participation, fidelity, and acceptability allow the team to understand how participants are receiving a program and which components are successful or

unsuccessful. Project stRIde program and camp staff were interviewed at the end of each summer to identify challenges, successes, and future iterations. In addition, a variety of process measures were used to assess the implementation of Project stRIde from the perspective of youth participants and camp staff. This iteration cycle ensured all interview and process data collected were assessed and changes were incorporated for the following summer.

Another strategy we found useful was the addition of youth perspectives in team collaboration and decision making. Youth have unique perspectives and can help build the capacity of adults to understand their experiences (Desiree L Tande & Doris J Wang, 2013). In this study, youth completed qualitative interviews after each lesson to provide their feedback. In addition to centering youth voices and involving youth directly in research, these qualitative data collection methods proved more reliable, and feasible than traditional pre- and post- intervention surveys.

Develop Theory and Knowledge Related to Learning and Implementation Through Systematic Inquiry

Although studying program development and implementation is an important concept in DBIR, an additional focus is to develop new knowledge related to the implementation experience (Fishman & Penuel, 2018; LeMahieu, Nordstrum, & Potvin, 2017). Theories and knowledge are derived from the implementation of programs and are intended to be used across a range of settings, not solely for a specific program. Examples include new learning theories, evaluation methodologies, or evidence-based claims about general concepts found to work best for specific populations. This principle further exemplifies the collaborative and ongoing process of addressing problems.

The generation of new knowledge was especially relevant to Project stRIde. Project stRIde is one of the first summer youth outreach programs to incorporate nutrition and STEAM education together, therefore there was no prior roadmap to follow. Through DBIR, the team gained a better understanding of working in a summer camp setting to deliver academic-focused lessons. Several program implementation models were used over the three years to better fit the needs of participants. The program shifted from classroom-style learning to fun, hands-on learning with opportunities for team building. Evaluation strategies for the program changed each year, ultimately landing on a qualitative-focused approach.

Develop Capacity for Sustaining Change

Though the final DBIR principle primarily relates to sustaining changes in educational systems, it can also be applied to the issue of sustainability in outreach programming. This principle is concerned with developing the capacity of individuals, settings, and institutions to effectively implement and scale programs (Fishman & Penuel, 2018; McKay, 2017). A common individual strategy is to provide professional development opportunities for facilitators (Fishman & Penuel, 2018). Changes at the institutional level include supplying updated materials or equipment to create more adequate program settings (Fishman & Penuel, 2018). It is important to provide equal access to materials generated from the program for all personnel. This can help foster long-lasting relationships with community partner team members and organizations.

One example of this principle in action is the sustainable model created through collaborative efforts in Project stRIde. Though the grant will end, team members discovered a way to create access to program activities without the need for facilitators.

The lessons were split up into individual kits with activities and directions suitable for a fifth grade reading level. These kits will be distributed to community partners all over the state for no cost.

Through the use of multi-level partnerships and collaborations, DBIR is useful in structuring the development, implementation, and dissemination of youth-centered outreach programming. Similar outreach programs should consider this methodology when designing and implementing programs.

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CHAPTER 3

MANUSCRIPT

This manuscript was prepared in accordance with author guidelines for the Journal of Nutrition Education and Behavior. It is currently in preparation for submission.

Title: Examining the Impact of a Nutrition-Centered STEAM Program for Urban Youth from Low-Income Families

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Funding Sources: This research was supported by a Children, Youth, and Families at Risk (CYFAR) research grant awarded from the United States Department of Agriculture (USDA)

ABSTRACT

Background: Youth from under-resourced communities are at increased risk for academic challenges and nutritionally inadequate diets. Out-of-school programs offer an opportunity to engage students and foster interests in science, technology, engineering, arts, and math (STEAM). Project stRIde: Science and Technology Reinforced by Innovative Dietary Education is a novel program which provides nutrition-focused STEAM education to populations affected by learning loss.

Objective: Evaluate the effectiveness of Project stRIde including interest and choice in STEAM, intended behavior changes, program acceptability, appropriateness, feasibility, and overall program impact.

Study Design, Settings, and Participants: This mixed-methods study included 4-7th grade youth (n=60), camp staff (n=4), and program staff (n=4) at three urban summer camp sites over six weeks. A pre- and post-test design measured student interest and choice in STEAM (SIC-STEM Survey). Camp staff completed an acceptability of intervention, intervention appropriateness, and feasibility of intervention measure (AIM, IAM, FIM) post-intervention. Interviews were conducted post-intervention with youth participants and staff to assess STEAM and nutrition knowledge gained, intended behavior changes, acceptability, and overall impact.

Measurable Outcome/Analysis: Paired *t*-tests were used to compare pre-to post-SIC-STEM survey data. AIM, IAM, FIM scores were averaged to show level of success. Interviews were transcribed and coded using an inductive and deductive approach. Interrater reliability was assessed and a thematic analysis was conducted to identify preliminary themes. Dose delivered was summarized.

Results: Approximately 86% of participants attended three or more out of six lessons provided. Themes include: program acceptability, positive impact on STEAM and nutrition knowledge, program model was simplified and guided by youth choice, summer camp setting was a barrier, and perceived impact on participant engagement and enjoyment. There were no significant changes in pre- to post-SIC-STEM survey scores. Camp staff rated Project stRIde as acceptable, appropriate, and feasible.

Conclusion: Project stRIde was rated as acceptable, engaging, and shows promise in mitigating learning loss among at-risk youth. Future directions include adapting this program for afterschool settings and working with community partners to promote program sustainability.

INTRODUCTION

Importance of STEAM-Focused Outreach Programs

Science, technology, engineering, arts, and mathematics (STEAM) education is a relatively new pedagogical approach to inspire learning and creativity.[1,2] STEAM-based curricula aims to connect school lessons to real-world situations and excite students about possible career opportunities.[1,2] This multi-faceted approach increases critical thinking skills, motivation, and engagement.[2] STEAM outreach programs are a useful tool to decrease summer learning loss, or the loss of information gained over the school year.[3,4] Summer learning loss is a widespread issue that affects students of all ages and socioeconomic status (SES).[5,6] Losses in school year learning range from one to three months in some subjects.[6] These losses were exacerbated by the COVID-19 pandemic.[7] Simulations predict a global decrease in the ability for youth to meet reading comprehension goals and an increase in drop-out rates.[8] The largest inequities are observed in youth from low-income families and racial and ethnic minority groups.[7,8]

Practitioners have turned to summer outreach programming to help mitigate the severity of summer learning loss.[5,6] Summer outreach programs can also provide an opportunity for students who are behind catch up to their peers.[6,9] In one STEM-focused summer program for youth aged 10-16, activities such as creating products and learning basic STEM skills were found to be appropriately challenging and relevant by youth.[10] A review article that analyzed studies of summer programs with mathematical education found that those who participated in these programs had significantly positive results on educational outcomes.[11] This analysis primarily included students from low-income communities.[11] Other youth programs, such as 4-H, include STEM education in their

curricula to promote confidence and positive youth development.[12] These studies exemplify the potential of supplemental STEAM education, especially in youth from low-income communities.

Importance of Nutrition Education for Youth from Low-Income Families

Individuals with lower SES and racial and ethnic minority groups experience an increased risk of developing diet-related chronic diseases and overall poorer health.[13-15] Individuals with low food security are at higher risk for developing type 2 diabetes, hypertension, and cardiovascular disease, among other diseases.[13] Hispanic and non-Hispanic Black individuals are more likely to have poorer health than their White and non-Hispanic counterparts.[14] Dietary patterns begin early in childhood when youth have increased autonomy to make their own decisions.[16] Studies show that poor dietary habits learned in early adolescence are likely to carry into adulthood.[16] This makes childhood and early adolescence a crucial time to implement nutrition education.[16] There is also evidence to suggest that dietary quality among youth declines during the summer months, especially in racial and ethnic minority groups.[17] Several nutrition education programs such as the Supplemental Nutrition Assistance Program- Education (SNAP-Ed) work to increase healthy dietary behaviors among youth.[18]

Nutrition-focused STEAM programs are limited but may be beneficial to decreasing summer learning loss while simultaneously fostering healthy dietary behaviors in youth. FoodMASTER is a free, food-based STEM curriculum intended to teach science and mathematics concepts to grades 3-8.[19,20] This program increased 4th grader knowledge in several science topics including Life Science and Physical Science, demonstrating that a nutrition-centered STEM curriculum may increase knowledge in this

population.[19] A food-based STEAM curriculum implemented in *Head Start* preschools showed a significant increase in skin carotenoid levels compared to a control group.[21] While this intervention focuses on a younger population, it demonstrates the ability to impact behavior change by increasing fruit and vegetable intake through nutrition-centered STEAM education.[21] Besides the aforementioned studies, there is a lack of literature evaluating outcomes of nutrition-centered STEAM curriculums in youth in an out-of-school (OST) setting.

Involving Community Partners in Curriculum Development and Implementation

Implementation science (IS) is the study of methods to inform effective and sustained community interventions.[22,23] IS is especially relevant to continuously evolving program designs, such as curricula that undergo multiple rounds of edits.[22] Design-Based Implementation Research (DBIR) is a facet of IS in which educators, community partners, researchers, and other key personnel work together to design and implement an intervention.[24] Several studies have used DBIR in formal education settings, though it is not commonly used in nutrition education outreach programs.

DBIR is especially useful in working to identify challenges in youth programs. For example, in a study by Subramaniam et al., researchers collaborated with library staff to design a toolkit for youth library services.[25] This interdisciplinary team identified issues with program appropriateness and staff member facilitation.[25] DBIR studies typically include numerous community partners in each stage of curriculum development.[25] DBIR is vital to curriculum revisions, creating materials, and other needs for implementation and sustainability.[24,25]

This study seeks to examine changes in main outcomes of Project stRIde: Science and Technology Reinforced by Innovative Dietary Education. Project stRIde previously underwent a rigorous formative evaluation followed by two developmental, pilot years.[26] The program arrived at its current and final model in year three after collaborative curriculum edits through the DBIR framework. We hypothesized that the program would increase participant interest and choice in STEAM, positively influence nutrition-related behavior changes, and positively impact participants. We hypothesized that community partners and program staff would find Project stRIde acceptable, engaging, and adequately adapted to fit participant needs.

METHODS

Intervention

Project stRIde is a nutrition-focused STEAM summer program for youth in grades 4-6. This program was delivered in Rhode Island communities that are primarily low-income, racially and ethnically diverse, and urban. It was delivered in three community partner summer camp sites by nutrition and 4-H professionals. The goal of Project stRIde was to educate and excite youth about STEAM subjects through engaging, nutrition-centered activities. Sample lessons included Think Your Drink, in which participants learned about the importance of choosing healthy beverages while integrating math and art into the lesson. They calculated how much sugar was in a bottle of soda if it was consumed over one week, month, and year. They then created sand art as a reminder of how much sugar is in a bottle of soda. Lessons and activities within each lesson are expanded on in **Table 6.** The format of the curriculum was inspired by 4-H STEM kits. The materials for each lesson were packed into a file-sized bin to ensure ease and the

ability to replenish supplies without difficulty. This study was part of a United States Department of Agriculture (USDA) Children, Youth, and Families at Risk (CYFAR) grant. This study was approved by the University of Rhode Island's Institutional Review Board.

Sample

Youth Participants. Youth participants attended camp at one of the three participating summer camp community partner sites. Participants ranged from the 3-7th grade level and were primarily from low-income, racially and ethnically diverse, and urban communities. Over half of youth in these communities qualified for free or reduced-price lunch (FRPL).[27] Participation in the program was included with registration for summer camp. Parents/guardians signed an informed consent form in order for their child to be included in data collection.

Community Partners & Program Staff. Data from community partners and program staff are included in this analysis. Community partners observed Project stRIde and held a management position at one of the program sites. Program staff included nutrition and 4-H professionals that delivered and/or helped to facilitate the program.

Data Collection

Youth Participants. A brief demographic survey (7 items) was administered to youth during week 1 only to collect age, sex, race, and ethnicity information. Dose and fidelity were recorded through attendance sheets and fidelity checklists, respectively. Participants completed the Student Interest and Choice in STEM (SIC-STEM Survey 2.0) (**Appendix 2**).[28] In applying the retrospective pretest-posttest design, youth were given the SIC-STEM survey twice.[29,30] The first time, youth reported current behaviors relating

to interest and choice in STEM.[29,30] One week later, they were asked to answer retrospectively, reporting behaviors from just before the program began.[29,30] The SIC-STEM Survey 2.0 has been tested for reliability and validity.[28] Only the Engineering and Technology domain were used, which consisted of 15 questions using a 5-point Likert scale of Strongly Disagree to Strongly Agree.[28]

In addition to the SIC-STEM survey, youth were asked to participate in informal, semi-structured interviews at the end of each lesson following a similar, but not identical approach to Luesse et al.[31] Interviews consisted of 2-3 open-ended questions aiming to identify participant attitudes towards STEAM, intended behavior changes, and process outcomes. Attitude and behavior change questions were designed based on lesson constructs and major activities performed each week. Open-ended process questions about interest, future implications, and topics learned were adapted from 4-H Common Measures.[32] Sample questions included, *Today we talked about fruits and vegetables. What new things did you learn today?* And, *What are some changes you might make, if any, with fruits and vegetables after reading the Eat the Rainbow book?* The full list of participant interview questions can be found in **Appendix 3**. Interviews took place at the end of each lesson and were audio recorded using a tape recorder. Every week, a different sample of 2-3 participants at each site was chosen from random selection on the attendance sheet. Each participant was interviewed at least once to ensure varying levels of participation and awareness of content were represented.[31] Students were asked the questions one-on-one for more accurate transcription and as to not bias other respondents. They chose a small incentive (pen, beach ball, puzzle, or rubix cube) upon completion of interviews.

Community Partners & Program Staff. The interviews with community partners and program staff aimed to identify perceptions of acceptability, changes from previous years, and the overall program impact. Community partner and program staff questions can be found in **Appendix 4.** These interviews were completed upon program conclusion in late summer 2023. Interviews were conducted over Zoom© and were video and audio recorded. Additionally, community partners only completed the Acceptability of Intervention, Intervention Appropriateness, and Feasibility of Intervention Measure (AIM, IAM, FIM).[33] Each measure consisted of four questions on a scale of completely disagree to completely agree.

Data Analysis

Youth Participants. Dose, reach, and fidelity checklists were compared between sites as process evaluation data. Paired *t*-tests were used for the SIC-STEM survey questions between retrospective pretest and posttest using SAS©.[28] Recorded youth interviews were transcribed verbatim by two members of the research team and coded by two coders in Dedoose©. A codebook was established based on the literature and topics from previous informal interviews with participants.[34] As the coders progressed, they met regularly and added codes as new main ideas arose. Inter-rater reliability was assessed to ensure agreeability between the two coders. However, due to the brief nature of participant responses, the majority of participant interview data were expressed quantitatively as percentages.

Community Partners & Program Staff. The community partner and program staff interviews were analyzed according to the methodology above. A separate codebook was established based on the literature and interviews from past years.[34] A thematic

analysis was completed using an inductive and deductive approach to coding.[32] Major themes were derived from the community partner and program staff interviews. The established protocol for the AIM, IAM, and FIM surveys was to express the results as means, with means above average scores (3.0) indicating program acceptability, appropriateness, and feasibility.[35]

RESULTS

Youth Participants. Youth participants (*n*=60) primarily identified as Black or African American (62%) and approximately 40% identified as Hispanic or Latino. The majority of participants (90%) were in grades 4-6. Remaining demographic information is displayed in **Table 1**. Overall, 86% of participants attended three or more lessons. Fidelity checklists reported high fidelity (80% or greater) across all sites.

Twenty-nine participants completed both the retrospective pre- and post-SIC STEM survey. There were no significant differences in pre-to post-survey scores. Results and illustrative quotes from youth interviews (*n*=40) are provided in **Table 2**. Overall, the majority (87.5%) of participants interviewed learned a new STEAM or nutrition concept. For example, one participant explained, *"I think it was cool I actually learned something. I was kind of confused at first but I kind of got the hang of it and I wanted to keep doing it because it was fun."* Approximately 70% of participants enjoyed the hands-on activities of the lessons such as sand art or pH testing. Lastly, 37.5% of participants intend to make a nutrition-related behavior change, including eating more healthy fruits or drinking healthier beverages. One participant stated, *"It felt like I kinda wanted to test all the different drinks and see for myself. It actually made me feel more like... More careful with drinking choices."*

Community Partners and Program Staff. Information about community partners (*n*=4) and program staff (*n=4*) is displayed in **Table 3**. Two camp counselors, two camp leadership professionals, three nutrition professionals, and one 4-H professional were included in the interviews. Three separate camp staff at each site completed the AIM, IAM, and FIM. Mean scores were above average for each measure (**Table 4**). The highest possible score to achieve is a 5.0. All camp staff rated each statement as either *Agree* or *Completely Agree* with the exception of one statement; *Project stRIde seems applicable*.

Five themes were derived from the community partner and program staff interviews including 1) program acceptability, 2) positive impact on participant STEAM and nutrition knowledge, 3) final program model was simplified and , 4) summer camp setting was a barrier, and 5) perceived impact on participant engagement and enjoyment. Each of the themes are described below and further elaborated on in **Table 5**. Inter-rater reliability among coders indicated good agreement (pooled Cohen's *kappa*= 0.73).[36]

Program acceptability. Community partners and program staff found the program to be enjoyable and valuable to participants. Staff that have seen the program over multiple years agreed that Project stRIde was delivered in its most successful format thus far. Community partners commented on the positive relationships program staff formed with participants. One strength commonly identified was the importance of the program providing STEAM and nutrition education in a fun, engaging style. One community partner commented, *"I think it was combined with fun – fun and learning combined together so, it was pretty smooth."*

Positive impact on participant STEAM and nutrition knowledge. Staff and community partners believed that participants learned STEAM and nutrition concepts. Participants were able to recall information learned during the first week of camp throughout the summer. Community partners especially highlighted the knowledge gained in nutrition education that youth may not have known before. According to a program staff member, participants were introduced to new STEAM concepts which may help when they return to school in the fall.

Final program model was simplified and gui*ded by youth choice.* This theme features feedback on the collaborative edits that resulted in the final program model in the third year of programming. Community partners and program staff were pleased by the simplification of the curriculum. They also commented on the addition of more hands-on, fun, and team building activities. According to camp and program staff, this design was more *"flexible," "engaging,"* and *"participant-led."*

Summer camp setting was a barrier. The primary barrier identified in interviews was the summer camp setting overall. Program staff discussed issues with camp staff turnover and difficulty communicating with camp counselors. Both community partners and program staff observed that STEAM is a difficult topic to teach during the summer when youth are preoccupied with other fun activities offered by the camp and less learning focused. A program staff member explained, *"Summer is just a hard time because you're working against the cycle of education. Like you're just not getting kids when they're in the head space to do learning."* In addition, the short length of the program was mentioned as another drawback to the summer camp setting.

Perceived impact on participant engagement and enjoyment. Community partners and program staff stated that Project stRIde was overall well-liked by participants when asked about youth perspectives. Community partners endorsed the use of hands-on activities to engage participants, especially in this age group. They revealed that participants looked forward to the program each week, enjoyed program staff, and appreciated educational extenders. Overall, the program was discussed as "*engaging*," *"interactive,"* and "*participatory*."

DISCUSSION

Project stRIde delivered nutrition-centered STEAM education to youth from primarily low-income, racially diverse, and ethnically diverse communities in a summer camp setting. Attendance and fidelity were high across all summer camp sites. Leveraging the principles of DBIR, major revisions were informed by community partners, program staff, youth, and the research team to land on this final program model. This final program model was rated as acceptable, feasible, and appropriate by camp staff. Community partners and program staff found this model to be well-adapted to fit participant needs. Though youth interest and choice in STEAM remained unchanged as measured by surveys, the majority of participants stated they learned something new in interviews.

Absence of change in the SIC-STEAM survey could be due to a variety of factors, including participant fatigue, lack of interest, and evaluation style. Participant fatigue is common in youth.[37] In this study, participants were asked to complete required, lengthy surveys required by the funding agency in addition to the SIC-STEAM survey. Though the SIC-STEAM survey only consisted of 15 questions, participants complained about

the length of the survey. The research team sought to identify shorter STEAM interest surveys, however, there is a lack of validated and relevant surveys for this age group. In addition, participants were disappointed that this process decreased the amount of time spent on fun, hands-on activities. Engagement was significantly diminished when paper and pencil activities were introduced despite the topic. A retrospective pre- and post-test design was used in the final program model to attempt to reduce this issue and the problem of attrition. Participants were given the SIC-STEM survey twice. The first time, they were asked to report results based on their feelings from before the program began. The second time, they were asked to report results as they currently felt applicable. Summer camp programs, especially in low-income areas, have high rates of overall attrition.[38,39] About half of the participants completed both retrospective pre-and post-surveys, which were administered during the last two weeks of the program. Further, participants were somewhat confused that they were given the same survey twice. This indicated that a traditional, pre- and post-intervention survey design may be easier to comprehend. There is a need for more engaging methods of youth data collection and appropriate measures to evaluate STEAM interest.

Youth participants interviewed discussed learning STEAM and nutrition topics and intended on making nutrition-related behavior changes. The majority of youth were eager to participate in interviews and valued being asked about their experiences in the program. Qualitative data collection methods allow for youth to expand on their experience and reflect on future behavior change.[40] A similar study implemented qualitative interviews with youth in an after-school program about highly processed foods (HPF).[31] While researchers did not find a significant change in HPF intake,

participants discussed eating more fruits and vegetables and noted the risks associated with consuming HPF in interviews.[31] This suggests that qualitative methods such as interviews are an effective way to evaluate youth perceptions.

Interviews with community partners and program staff helped to identify Project stRIde's strengths and limitations. Overall, community partners and staff were pleased with the hands-on learning experience provided by Project stRIde. They noted that participants learned important nutrition concepts they may not receive elsewhere. Community partners discussed the relevance of the STEAM concepts within Project stRIde. Some stated that this may reinforce concepts they have already learned or introduce concepts they will learn in the upcoming school year. One study by Roberts, et al. of a summer STEM program for youth assessed the impact of the program on participants' preparedness for the upcoming school year.[41] Results from interviews with participants showed that early introduction to these concepts would help youth prepare for their STEM classes.[41] The hands-on and real-world activities in the program also allowed participants to connect STEM learning from the program to their school subjects.[41] Both community partners and camp staff indicated that participants enjoyed the program through observation or youth feedback. Results from the AIM, FIM, IAM indicated that camp staff perceived the program as acceptable, feasible, and appropriate.

Interviewees identified the final program model of Project stRIde as the strongest. DBIR allowed for ongoing conversations with community partners and program staff to create yearly edits to the curriculum. The final program model contained only 1-2 nutrition or STEAM concepts per lesson, instead of 3-4 in previous years. Program staff implemented fun, team building activities at the end of each lesson to further establish

trust and promote youth engagement. Other studies implementing DBIR made similar edits to their curricula. In a study conducted by Nation et al., researchers and practitioners analyzed the STEMinist Program curriculum, an afterschool STEM program for Latina girls.[42] After analyzing participant interviews, researchers found their feedback to be useful in creating program edits to enhance their experiences.[42] For example, when participants asked how they were like scientists, several participants questioned this language and preferred to be referred to as "*scientists*," not "*like scientists*."[42] Researchers planned to use more deliberate, person-centered language in the second year of programming to establish trust and build confidence in participants.[42] In this study various personnel including youth participants collaborated to create impactful, youth-centered changes to the curriculum.

The summer camp setting was the main barrier to implementing Project stRIde. Summer is a difficult time to engage participants, especially within the camp setting. We found that camp staff had a high turnover rate and often were not present to assist with classroom management. This became difficult when trying to create sustainable relationships with community partners. In addition, we found that youth are often distracted by other activities at the camp, such as swimming or using computers. Fostering excitement about STEAM or nutrition is more difficult when youth have been away from a school-style learning environment. In a study that analyzed a summer STEM outreach program for middle and high school students, participants also complained of surveys, written work, and the subject matter as their least favorite part of the program.[43] This suggests that STEAM education may not be the ideal topic for summer camp settings. Lastly, youth did not have a choice in the type of enrichment they received. In

other studies of summer STEAM programs, participants may have had the option of which type of enrichment they received. Overall, Project stRIde may be better suited as an after-school program when students are already in a learning mindset, as suggested by multiple program staff in interviews.

Future Directions

Future directions for Project stRIde include plans for sustainability, changing the program setting, and continuing with innovative evaluation methods such as participant interviews. Project stRIde will be offered in after-school and short school break settings in the final grant year to explore the effectiveness of the program in other contexts. This was decided after discussions with community partners and program staff. All parties agreed that summer is a difficult time for STEAM programming and after-school or shorter school breaks, such as February vacation, may be better fits. The program will continue to implement innovative evaluation methods to assess program effectiveness. Qualitative methods will be used when possible. The curriculum will continue to be delivered in the 4-H STEM kit-inspired format, with each lesson packed fully into a bin. Project stRIde will be delivered this way in the final year of programming.

In the long-term, we hope to contribute to the sustainability of Project stRIde by disseminating these kits to community partners throughout the state. Libraries, camps, and schools will have access to the activities with clear directions. These materials will be available at no cost to community partners and can be used for supplemental teaching materials, program curricula, or fun learning activities.

IMPLICATIONS FOR RESEARCH AND PRACTICE

This study shows that a nutrition-focused STEAM outreach program positively impacts racially and ethnically diverse youth from low-income families. Youth were exposed to important nutrition concepts they may not receive education on elsewhere. STEAM education during the summer is important in mitigating summer learning loss. These factors are especially important for youth from low-income, racially diverse, and ethnically diverse families who are at risk for academic challenges and nutritionally inadequate diets.[5,6,13-15] Future studies should consider pairing nutrition education with engaging, hands-on topics, such as STEAM.

There is a need for more innovative, engaging methods of data collection such as participant interviews. Evaluation in youth programming, especially during summer, is difficult and tedious. Youth were unengaged in paper-and-pencil surveys despite researchers using a new and promising survey administration method. Engaging methods of youth data collection may result in more reliable and accurate data.

One of the major highlights of Project stRIde was its ability to evolve into an engaging, youth-centered model. Collaborations with researchers, community partners, participants, and program staff were effective in creating sustainable edits to the curriculum. This method has shown promise in other studies, but is rarely used in outreach settings.[25,42] Overall, outreach programs should consider incorporating principles of DBIR into their curriculum development and revision phases.

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Table 1. Demographics of Project stRIde Participants in Year 3 of Programming

	n	Percentage (%)
Total Participants	60	100.0
Gender		
Male	34	57.6
Female	29	49.1
Grade		
3	1	1.6
4	13	21.7
5	25	41.6
6	16	26.7
7	5	8.3
Ethnicity		
Hispanic or Latino	23	41.1
Race		
Asian	2	3.8
Black or African American	33	62.3
White	6	11.3
Other	4	7.5
More than one race	8	15.1

Table 2. Quantitative and Qualitative Feedback from Participant Interviews (*n*=40)

Participant Feedback	*n*	%	Quotes
Learned a new nutrition concept	27	67	*"Go is a healthy food you should go eat it"*
			"The different colors mean different things, like different things that will help you. I didn't know it was the colors of the fruits and vegetables"
Learned a new STEAM concept	17	42.5	*"I think in school [STEAM] helps you know certain things and helps you a lot like things you wouldn't know and now I do know. So it helped me a lot"*
			"Yeah I didn't know that, when your heart pumps blood and sends blood to your heart and to your body."
Learned a new nutrition or STEAM concept	35	87.5	
Did not learn any new concepts	4	10	*"This was not new to me."*
Enjoyed hands-on activities	28	70	*"[My favorite part was] measuring out how much sugar we would be drinking with added sugar if we was drinking it from days, weeks, and months."*
			"It was really fun and then you get to take a guess and then see if you got it wrong or if you're right so it's really fun and you can get the stuff at stores and stuff and you can try it out with your family and have a fun time with them."
Intended to make a nutrition-related behavior change	15	37.5	*"It felt like I kinda wanted to test all the different drinks and see for myself. It actually made me feel more like... More careful with drinking choices."*
			"Yeah. I'll start doing milk, more milk, more water."
			"I might eat more fruits"

Table 3. Program Experience of Community Partners and Program Staff Involved with Project stRIde

	n
Total Participants	8
Affiliation	
Community Partner	4
Program Staff	4
Role	
Camp Leadership	2
Camp Counselor	2
Nutrition Professional	3
4-H Professional	1
Years Involved with Project stRIde	
1 year	1
2 years	0
3 years	1
4 years	6

Table 4. Acceptability of Implementation (AIM), Intervention Appropriateness (IAM), and Feasibility of Intervention Measure (FIM) Results from Camp Staff Participants in Year 3. Measures are scored on a scale of 1- Completely Disagree, 2- Disagree, 3- Neither Disagree nor Agree, 4- Agree, and 5- Completely Agree. Community partner participants are represented by P1-3.

Acceptability of Implementation Measure (AIM)	**P1**	**P2**	**P3**	**Mean Score**
1. Project stRIde meets my approval.	4	4	5	4.33
2. Project stRIde is appealing to me.	4	4	5	4.33
3. I like Project stRide.	4	4	5	4.33
4. I welcome Project stRIde.	4	4	5	4.33
AIM Mean (SD)				**4.33 (0.49)**
Implementation Acceptability Measure (IAM)	**P1**	**P2**	**P3**	**Mean Score**
1. Project stRIde seems fitting.	4	4	5	4.33
2. Project stRIde seems suitable.	4	4	5	4.33
3. Project stRIde seems applicable.	4	3	5	4.00
4. Project stRIde seems like a good match.	4	4	5	4.33
IAM Mean (SD)				**4.25 (0.62)**
Feasibility of Implementation Measure (FIM)	**P1**	**P2**	**P3**	**Mean Score**
1. Project stRIde seems implementable.	4	4	5	4.33
2. Project stRIde seems possible.	4	4	5	4.33
3. Project stRIde seems doable.	4	4	5	4.33
4. Project stRIde seems easy to use.	4	4	5	4.33
FIM Mean (SD)				**4.33 (0.49)**

Table 5. Qualitative Themes and Illustrative Quotes from Community Partner and Camp Staff Interviews (*n*=8)

Themes	*Supporting Quotes*	Participant
Program Acceptability	*No. Actually, I think it was combined with fun – fun and learning combined together so, it was pretty smooth.*	Community Partner
	I mean, I thought it was very valuable hearing about the stuff they're learning about. I don't know if they actually get a lot of that stuff in school or here, you know? So, to have them, you know – someone tell 'em how much, you know, "This is how much sugar is in – " They've never heard that before, you know? My goal here at the club is always trying to expose them to as many things as possible so, having someone come in that's – a unique program – I think it's great.	Community Partner
	I thought it was great. I thought the curriculum content was on point and was just enough content for the kids to be engaged but not be saturated with information and didn't feel like we were rushing through the lessons. Didn't feel like we were running out of time.	Program Staff
	I think that it's another group of mentors that they feel that the teachers care about 'em, you know? And I think that makes 'em be more invested in the program.	Community Partner
	Um, it seemed like it gave them something fun to look forward to, uh, which was great. 'Cause like watching them come in and they're excited to see like what are we up to. What did you guys bring? What's going on? Like I like that little bit of, uh, excitement.	Program Staff
Positive Impact on Participant STEAM and Nutrition Knowledge	*I think it affects them and, you know, it makes them stop and look. "Oh, really? I'm consuming that much sugar.*	Community Partner
	There was definite learning about nutrition which was really cool. Um, so I think there was clear knowledge gained which is probably the most important thing, like what we were all aiming for which is fantastic.	Program Staff
	And I think most telling was from the last class when we kind of did the game and recapped what they learned. I was really impressed that they	Program Staff

	remembered things from week one. That was just one part of week one and they remembered that information.	
	Um, I think when I noticed it the most was that they were able to retain and recall information on that final day during that competition.	Community Partner
	I think it was a great program 'cause it let the kids know what they're putting in their body and what's in the things that they're drinking and eating.	Community Partner
	And we ended with a summer camp fun hour of activities and engagement and teamwork and things like that. And we did find that the knowledge that they learned and the concepts they learned was the same if not more when we had, um, more of that. So I think that was cool.	Program Staff
	I found that it was more interactive this year. Um, like it was last year, but I feel like it was a whole new mile like, more. 'Cause when you were mentioning the tie-dying and stuff, I was like, "Oh, cool. Okay."	Community Partner
	Simplified curriculum, more activities that were really more innovative and thus more engaging to the kids. I thought we kind of got a little more creative with our activities over the years as opposed to just being like we'll teach think your drink. It's like oh we'll do it with sand art. You know, I thought that was great.	Program Staff
Final Program Model was Simplified and Guided by Youth Choice	*But, um, I also think that like we all became a little less rigid as the program went on in terms of like if this activity was taking a long time where like ok, the kids are into it. Let's extend this as long as we can. So I think the team dynamic amongst like the staff and educators improved as we became more flexible and more adaptive to what we were actually seeing like in the classroom.*	Program Staff
Summer Camp Setting was a Barrier	*The community partners themselves were wonderful but they weren't really willing to take on any of it. They just were willing to sometimes be in the room and so I think that was hard. Sometimes they weren't always great about classroom management. That was challenging.*	Program Staff

	So you're definitely the outsider in these kids lives too. So you know, establishing these relationships with them. You're not someone that, you're not their teacher for, you know, six days a week for 30 hours or whatever it is. So I think that's always hard with community outreach. And also, meeting them where they're at but, we talk about the concept of where, kids live, learn and play and we really only are going to six hours of where they play.	Program Staff
	Summer is just a hard time because you're working against the cycle of education. Like you're just not getting kids when they're in the head space to do learning.	Program Staff
	I feel like it's a tough thing to deliver in the summertime because the topic, though it's a cool topic is almost like a school vibes kind of topic.	Program Staff
Perceived Impact on Participant Engagement and Enjoyment	*The staff and the kids both said the same thing. They really enjoyed the program. The kids said that the staff were – they had fun. That's the number one thing, right? They said they were – the staff were nice. They had fun. Um, 'cause believe me, if they're not having fun or they don't like the program, they're gonna let us know right away.*	Community Partner
	I don't think I necessarily also got any like – I can't wait, but the tie-dye thing – they were asking about when you guys were gonna be coming back. So, I would say that it's definitely a big difference from last summer and there were definitely positive comments about like, the activities you did while you were there and then, they did question when you were coming back when you did the tie-dye.	Community Partner
	Um, if kids want you to be there and they look forward to you being there that makes them way more, you know, just open to learning in general. So I think that was a really key aspect this year that we were able to do.	Program Staff
	They're a lot of fun and they can be, sometimes, hard to engage, and I felt that, you know, every time I was in the room with all of you, they` had their moments, but, for the most part, they were engaged in activities, and I think that's like, the most important telling of how successful a program is. So, I would say my overall, thoughts and opinions on the program was that it was really strong, it was	Community Partner

	really good, and it was, I think, proven by the engagement that you had, you know, most of the time, with them participating in like, the activities and the games, the competitions.	

Table 6. Lesson Plan from Project stRIde Including Weekly Topics and Activities

Year 3		
Week	**Lesson**	**Activities**
		Ice-breaker
		Pre-surveys
		STEAM is Everywhere book
		Muffin tasting with and without baking powder
		pH testing activity
1	STEAM is Everywhere	Wrap-up, fun game, youth interviews
		Ice-breaker
		Finish pre-surveys
		Eat the Rainbow book
		Fruit & veggie beach ball activity
		Tie-dye shirts
2	Fruits & Vegetables	Wrap-up, youth interviews
		Ice-breaker
		Go, Slow, Woah book
		MyPlate Go, Woah board game
	Go, Slow, Woah, & Heart	Heart model
3	Health	Wrap-up, fun game, youth interviews
		Ice-breaker
		Think Your Drink book
		Calculate sugar in soda
		Sand art to represent sugar
4	Think Your Drink	Wrap-up, fun game, youth interviews
		Ice-breaker
		Review engineer and science jobs
	Engineering & STEAM	Engineering food towers out of spaghetti and marshmallows
5	Careers	Wrap-up, fun game, youth interviews
		Ice-breaker
		Jeopardy review game
		Post-surveys
6	Wrap-Up & Celebration	Popsicles and wrap-up

APPENDICES

Appendix 1. Extended Literature Review

Disparities Facing Youth from Low-Income, Urban Rhode Areas of Rhode Island

Youth from low-income, racially and ethnically diverse families are at risk for decreased academic achievement, developing mental illness, and developing inadequate diets.[1,2] This was only exacerbated further by the pandemic. Rhode Island Comprehensive Assessment System (RICAS) and the Next Generation Science Assessment (NGSA) scores from 5th grade public school classrooms in Providence and Newport were analyzed using data from the Rhode Island Department of Education.[2] Data show that only 10% of Providence 5th graders and 15.5% of Newport 5th graders received proficient scores on the RICAS math exam.[2] In the NGSA, 14% and 21% of students received proficient scores in Providence and Newport, respectively.[2] These scores are substantially lower compared to RI 5th grade students as a whole.[2] This academic achievement gap is reflected in the United States (U.S.) as a whole. Evidence suggests a persistent gap exists between high- and low-income school districts in terms of academic achievement.[3,4] This may be due to differences in school resources, parental education levels, or income segregation.[3,4]

Standardized test scores have decreased nationally in the years following the pandemic, but the largest gaps in elementary school scores are seen in schools in lower-income areas.[5] However, test scores are only one aspect affected by the pandemic. Youth may have missed out on important social and developmental skills due to school closings.[1,6] Youth mental health has declined as a result of distancing regulations due to

COVID-19.[1,7] Compared to pre-pandemic years, pediatric emergency visits for mental health have substantially increased.[8]

Another issue that affects elementary-aged youth is summer learning loss, the loss of information learned over the school year.[9] Summer learning loss previously disproportionately impacted low-income youth, but new evidence suggests it impacts youth across all socioeconomic strata.[9,10] Learning loss ranges are largely variable, ranging from one to three months of loss in math.[9] While data is still being collected, early evidence suggests the COVID-19 pandemic has magnified learning loss in STEAM subjects.[10] Experts suggest implementing programs to reinforce information learned over the school year targeted to students who may have fallen behind.[10,11] Programs held outside of school time (OST) offer a chance to engage students from racially and ethnically diverse backgrounds.[11] Innovative, OST programs may help to stimulate excitement about STEAM and provide food and nutrition context to STEAM subjects.

In the United States, children from racially and ethnically diverse and low-income communities not only have inadequate diets but are also at greater risk to develop diet-related disease and have poorer health later in life.[12] This can be due to lack of healthy food access, food cost, and lack of access to nutrition education.[13,14] The COVID-19 pandemic magnified these disparities. While it is too early to predict health outcomes in this population, behaviors during the pandemic changed for youth including more screen time, less exercise, and less balanced diets.[1,15] There is also evidence to suggest that diet quality among youth decreases during the summer months, especially in racially and ethnically diverse groups.[16] Hopkins et al. found that Healthy Eating Index (HEI) scores were lower in the summer compared to the school year for a diverse sample of K-5th

grade students from low-income neighborhoods.[16] Scores for total vegetables decreased while added sugars increased during the summer months.[16] Several nutrition education programs such as the Supplemental Nutrition Assistance Program- Education (SNAP-Ed) work to increase healthy dietary behaviors among youth.[17]

STEAM and Nutrition Outreach Programs

STEAM (science, technology, engineering, arts, and mathematics) education is a relatively new and encompassing approach to teaching common academic subjects.[18,19] STEAM education seeks to infuse curricula with real-world experiences to foster problem solving and critical thinking skills.[18,19] This type of learning inspires creativity and excites youth about possible STEAM career opportunities.[18,19] In addition, it increases motivation and engagement in these subjects.[18,19] STEAM-based summer learning offers an opportunity to engage students at risk of falling behind.

STEAM outreach programs are common in summers to combat learning loss and often have promising results. One meta-analysis of 37 studies analyzed the results of summer programs focusing on mathematics for pre-K to 12th grade youth from low-income families.[20] It was found that youth who participated in these supplemental summer programs experienced significantly higher mathematics achievement outcomes compared to those who did not participate.[20] Another study by Clarke-Midura et al. examined the effects of a computer science summer program on middle school youth.[21] This summer program taught middle schoolers the basics of computer programming with an emphasis on peer interaction and career promotion.[21] Results of the program showed that participants' interest in computer science and computer science careers increased at the end of the program.[21] Participant self-efficacy scores for computer programming also

increased.[21] Lastly, a similar summer program focused on delivering engineering education to middle school students in a Latino community.[22] This NASA camp provided engineering, algebra, and science education.[22] While participants stated they enjoyed the camp, no significant differences were seen in interest, self-efficacy, or motivation pre/post surveys.[22] Researchers claim this may be due to the difficulty to get participants to adequately complete surveys.[22] However, some evidence suggests STEAM-based summer programs can positively impact participant knowledge and interest.[20,21]

There are very few studies that have examined the impact of a combined nutrition and STEAM curriculum, despite the possible benefits. A nutrition-focused STEAM curriculum may address the issues of summer learning loss and adverse dietary behaviors faced by low-income youth.[23,24] One curriculum that combines STEAM and nutrition education in an OST setting is FoodMASTER. FoodMASTER is a similar curriculum to Project stRIde and uses food as a tool to teach science and mathematics concepts to grades 3-8.[23,24] This program increased 4th grader knowledge in several science topics including Life Science and Physical Science, demonstrating that a nutrition-centered STEAM curriculum may increase knowledge in this population.[23] However, nutrition-focused outcomes are still being analyzed.[24] Another food-based STEAM curriculum implemented in *Head Start* preschools aimed to increase vegetable consumption.[25] Results showed a significant increase in skin carotenoid levels in participants compared to a control group, indicating increased fruit or vegetable consumption.[25] Though this study includes a younger age group, it demonstrates the ability to impact behavior change by increasing fruit and vegetable intake through nutrition-centered STEAM education.[25]

Besides the aforementioned studies, there is a lack of literature evaluating outcomes of current, nutrition-centered STEAM curriculums in youth in an outside of school setting.

Evaluation of Youth Programming

Evaluating programs targeted towards youth is a difficult task. Researchers in youth outreach programming historically try a variety of measures before landing on an adequate tool. In a study of barriers Extension agents face, measuring program impacts, evaluating newly developed programs, and creating accurate evaluation tools were cited.[26,27] Issues of cultural competency and reading comprehension levels make survey development difficult, especially within low-income, racially and ethnically diverse communities.[27,28] Another study of quantitative data collection with youth in schools found time, wording of questions, and reliability of student responses to be main challenges in data collection.[28] However, one of the most widespread issues in youth program evaluation is attrition.[27-29] Attrition in OST programs due to program absence is especially prevalent in low-income communities for reasons including lack of interest, transportation, and/or time.[29,30] Researchers must be innovative and flexible with program design because of these challenges in data collection.[30]

Semi-structured interviews are useful when trying to understand an individual's point of view or unique behaviors and attitudes.[31] A semi-structured design allows for the interviewer to have set questions but explore other ideas and topics as they come up.[31] Youth should be seen as autonomous participants and their voices should be centered throughout the data collection process.[31,32] Interviews allow for youth to expand on their program experiences and reflect on future behavior change.[31,32] In interviews with youth

after an OST healthy eating program, students commented on topics such as self-regulation around food and their change in preferences for fruits and vegetables.[31,32]

Traditional qualitative methods used with youth such as focus groups, interviews, and observations are valuable and may provide further context when used in tandem with other methods.[33] While the traditional pre- and post-test model has been established as a robust means of data collection, it does not take into account the complexities of working with youth in a summer setting.[34] Limitations include ample time, two time points of attendance, and a possible response-shift bias.[34] One way of combating these limitations in youth evaluation is using a retrospective pretest. The retrospective pretest design is commonly used in Extension programs with youth to recall what they have learned over the course of a program.[34] Shilts and colleagues state this method is an acceptable substitute for the pre- and post-test model to measure dietary behaviors and is recommended for 4-H and other Extension programs. However, there is a lack of innovative, engaging quantitative data collection methodologies for youth.[34]

Curriculum Development and Revision Through Design-Based Implementation Research

According to Luger and colleagues, community-engaged research (CEnR) describes approaches used to engage and establish partnerships with community partners, organizations, and those being studied.[35] CEnR allows researchers to discover a better understanding of the target population's needs and allows community members to have direct input and impact intervention outcomes.[36,37] One approach to engaging the community in research is design-based implementation research (DBIR). In DBIR, several key personnel such as educators, community partners, and researchers, come

together to identify problems in program delivery.[38,39] This group works together to effectively develop interventions using mixed methods approaches.[38,39] There are four key principles to DBIR: 1) focus on persistent problems of practice from multiple perspectives, 2) commit to iterative, collaborative design, 3) develop theory and knowledge related to learning and implementation through systematic inquiry, and 4) develop capacity for sustaining change.[38,39] Several studies have used DBIR in curriculum development, though it is not commonly used in informal outreach program development and implementation.

DBIR is primarily used in situations where program design is iterative and flexible.[38,40] In a study conducted by Nation et al., researchers and practitioners analyzed the STEMinist Program curriculum, an afterschool STEM program for Latina girls.[40] Researchers analyzed several types of data including interviews, surveys, and observations to inform program changes such as integrating writing into science and art experiments and more opportunity for small group work.[40] Another study of the development of a chemistry curriculum for educators also used mixed methods during the revision process.[41] Both studies included numerous community partners in each stage of curriculum development.[40,41] Additionally, another study by Subramaniam et al. used DBIR processes to design and implement a toolkit for youth library services.[42] A team of researchers and library staff worked together to identify the main issues facing youth in libraries and the best way to address the issues.[42] This resulted in a professional development resource for use in all libraries across the country.[42] Previous studies show how DBIR is vital to curriculum revisions, creating materials, identifying problems, and sustainability.[40,41,42]

In conclusion, there is an evident gap in academic achievement and health outcomes in youth from low-income, racially and ethnically diverse families. Summer learning loss is a persistent issue that can affect youth of all ages and socioeconomic strata. Youth and early adolescence are critical times to begin healthy dietary behaviors. A nutrition-centered STEAM program may be effective at bridging these gaps, however, very few exist. Additionally, collaboration with community partners in research can produce more robust, mutually beneficial outreach programs. Though it is not commonly used in outreach settings, DBIR is a useful strategy for identifying problems, developing programs, and sustaining change.

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Appendix 2. SIC-STEM Survey 2.0 Engineering and Technology Domain Administered During Weeks 5 and 6 of Project stRIde

ENGINEERING AND TECHNOLOGY

Please read this paragraph before you answer the questions.

Engineers use math and science to invent things and solve problems. Engineers design and improve things like bridges, cars, machines, foods, and computer games. Technologists build, test, and maintain (or take care of) the designs that engineers create.

	Strongly Disagree	**Disagree**	**Neither Agree nor Disagree**	**Agree**	**Strongly Agree**
I do not like making new things. I am bad at building things.					
I can make things better by using math and science.					
I want to be an engineer.					
I use computers because I will need those skills in my job.					
I like to know how machines work. I am good at solving problems.					
I can invent new things by using math and science.					
I want to be creative in my job.					
The skills I learn while building things will help me in my job.					
I like to know how electronics work.					
I can use math and science to solve problems.					
Knowing how to design things will not help me in the real world.					
I want to take more classes in engineering.					
I work on engineering projects because I will need those skills in my job.					

Appendix 3. Questions Asked During Participant Interviews in Year 3, Separated by Lesson

Lesson 1: STEAM at Home

1. Today we learned STEAM isn't only helpful in school but it is a part of many different things we do, like baking! How do you think STEAM is useful in your life?
    a. Probe: Do you think you use STEAM in school?
    b. Probe: What about any future career plans or your other interests?
2. Today we learned that science is everywhere, even in our homes! What did you think about doing the science experiment with pH strips?
    a. Probe: what are some things you did or did not enjoy about the activity?

Lesson 2: Fruits and Veggies

3. Today we talked about fruits and vegetables. What new things did you learn today?
    a. Probe: Color function, different types of FV?
4. What are some changes you might make, if any, with fruits and vegetables after reading the Eat the Rainbow book?

Lesson 3: Go, Slow, Woah, and Fat

5. What new things did you learn today?
    a. Probe: Go, slow, woah?
    b. Probe: Heart health?
6. What is something about go, slow, and woah foods you might want to share with a family member or friend because you think it is important?
7. What did you think of the heart model we saw?
    a. Probe: What new things did you learn about how the heart works?

Lesson 4: Think Your Drink

8. Which parts of the lesson today were the most interesting to you?
9. How did the activities we did today make you feel about some sugary drinks that you might like?
10. What do you think about math problems like the one we did today with sugar?
    a. Probe: How do you usually feel about math?

Lesson 5: Engineering

11. What new careers in STEAM did you learn about today that you are interested in?
    a. Probe: Why does that interest you?
    b. Today we learned what engineers do. How do you feel about creating and building things, like an engineer?
    c. How do you think what you learned over our past 5 weeks together will help you in the future?

Appendix 4. Community Partner and Program Staff Interview Questions Year 3

1. **What was your role in program delivery or facilitation of Project stRIde over the past 3 years?**
    a. **Probe:** What role did you play in creating edits or facilitating changes made to the programming?

2. **What were your overall thoughts and impressions of the Project stRIde program delivered over the summer this year?**
    a. **Probe:** How does this compare to other outside programs, if any?
    b. **Probe:** Which aspects of the program do you think went well?
    c. **Probe:** Which aspects of the program do you believe could be improved?

3. **Do you think Project stRIde impacted youth in any way?**
    a. **Probe:** How?
    b. **Probe**: Were the impacts positive or negative? In what ways?

4. **Can you describe the changes in curriculum delivery and contents over the past 3 years?**
    a. **Probe:** Were there any changes in curriculum delivery? Content?
    b. **Probe:** How did these changes impact student engagement or acceptance of the program?

5. **What do you believe were the major improvements made to Project stRIde?**
    a. **Probe:** How did these changes affect the effectiveness of the program?

6. **What do you believe were some barriers to implementing the program across the years?**
    a. **Probe:** How did this change across the years?
    b. **Probe:** What was done to address these barriers?
    c. **Probe:** Are these barriers common in outreach programs?

7. **What advice would you give to staff trying to implement a program similar to Project stRIde?**
    a. **Probe:** How would this advice vary based on setting? For example, after school programs, summer programs, or in-school programs?

Appendix 5. Asking for Fruit and Vegetable Self-Efficacy at Home Survey Administered in Years 1 & 2.

Directions: Circle the answer that you disagree or agree with the most.

		I disagree very much	**I disagree a little**	**I am not sure**	**I agree a little**	**I agree very much**
1	I think I can ask someone in my family to buy my favorite fruit or vegetable.	A	B	C	D	E
2	I think I can ask someone in my family to make my favorite vegetable for dinner.	A	B	C	D	E
3	I think I can ask someone in my family to serve my favorite fruit at dinner.	A	B	C	D	E
4	I think I can ask someone in my family to have fruits where I can reach them.	A	B	C	D	E
5	I think I can ask someone in my family to have vegetables cut up where I can reach them.	A	B	C	D	E

Appendix 6. Youth Attitudes Towards STEAM (S-STEM) Questionnaire Developed by Unfried et al. and Administered in Year 1

Directions: STEAM stands for science, technology, engineering, art, and math. Please fill out the survey below by marking the box that best describes your feelings about each statement.

Question		NO!	no	yes	YES!
1	I think I am very good at coming up with questions and problems related to STEAM.				
2	I am confident that I can understand STEAM activities in class.				
3	Others ask me for help on STEAM activities.				
4	I like to design solutions to problems during STEAM design challenges.				
5	I can apply STEAM ideas to solve challenges.				
6	I am able to do well in activities that involve STEAM.				
7	I usually understand what we are talking about during STEAM activities.				
8	I love designing things!				
9	I like to figure out how things work.				
10	I feel satisfied when completing STEAM activities.				
11	After a really interesting STEAM activity is over, I can’t stop thinking about it.				
12	I enjoy learning about STEAM.				
13	Doing STEAM is fun.				
14	I like the challenge of STEAM activities.				
15	It is likely that STEAM will be part of my job someday.				
16	I want to learn as much as possible about STEAM.				

		NO!	no	yes	YES!
17	When I grow up, I want to work on a team with STEAM professionals.				
18	When I grow up, I want to work in STEAM.				
19	I see myself as a STEAM person.				
20	I feel like a STEAM person when I apply STEAM ideas to my life.				
21	My teacher sees me as a STEAM person.				
22	My best friends see me as a STEAM person.				
23	My family sees me as a STEAM person.				
24	My parents would like it if I chose a STEAM career.				
25	Others think that I would be a good STEAM person.				
26	Other kids in my class see me as a STEAM person.				

Appendix 7. Shortened Version of the S-STEM Survey Adapted from Unfried et al. Administered in Year 2

	Item	**I Strongly Disagree** 	**I Disagree** 	**I am Not Sure** 	**I Agree** 	**I Strongly Agree** 
1	I like math.					
2	I like science.					
3	I like reading.					
4	I like art.					
5	I like working with technology like computers, phones, tablets, and robotics.					
6	I like to build things.					

Appendix 8. Project stRIde Lessons and Activities Years 1-3 of Programming

Year 1		
Week	**Lesson**	**Activities**
1	Fruits & Vegetables: How they Grow and Help me Grow	Fruit and Vegetable video
		Life Cycle of a Plant video
		Compare and contrast activity sheet
		Plant life cycle activity sheet
		Plant growth data table
		Fruits and Veggies rock painting
		Pre- surveys
		Wrap-up
2	Experiments and Engineering with Food Groups	MyPlate video
		Go, Slow, Woah video
		Food Groups video
		Engineering snack structures blueprint worksheet
		Engineering food towers out of spaghetti and marshmallows
		Wrap-up
3	Hydration & Think Your Drink	Water is Wonderful video
		Think Your Drink video
		Sugar, sugar, sugar video
		How much sugar? Worksheet
		Sugar adds up activity
		Wrap-up
4	The Human Body: Fat Needs and Fast-Food Choices	Fat and Fast Food video
		Fast food riddles worksheet
		Rethinking your order activity sheet
		Chemical bonds puzzle
		Wrap-up
5	Your Kitchen is a Science Lab	Chemistry in the Kitchen video
		ABC name game
		Kitchen tools sorting cards

		Baking soda and vinegar activity
		Acid or base testing using black beans
		Wrap-up
6	Wrap-Up & Celebration	Post-surveys
		Review activities completed
		Popsicles and wrap-up

Year 2		
Week	**Lesson**	**Activities**
1	Fruits, Veggies, & Lifecycle of a Plant	Eat the Rainbow book
		Rainbow Review game
		Lifecycle of a Plant book
		Plant bean seeds
		Create an irrigation system
		Fruit & Vegetable BINGO
		Wrap- up
2	Think Your Drink	Think Your Drink book
		Calculate sugar in soda
		Sugar adds up activity
		How much sugar? Worksheet
		Wrap-up
3	STEAM is Everywhere	STEAM is Everywhere book
		STEAM dream career clouds
		Baking soda and vinegar activity
		pH testing activity
		MyPlate activity book
		Wrap-up
4	Go, Slow, Woah and Engineering	Go, Slow, Woah book
		Engineering food towers out of spaghetti and marshmallows
		MyPlate activity book
		MyPlate Go, Woah game
		Wrap-up
5	Fats and Fast Food	Fat activity book
		Heart model
		Calculate fat in fast food meals
		Fast food riddles worksheet
		Wrap-up
6	Wrap-Up & Celebration	Jeopardy review game
		Post-surveys
		Popsicles and wrap-up

Year 3		
Week	**Lesson**	**Activities**
1	STEAM is Everywhere	Ice-breaker
		Pre-surveys
		STEAM is Everywhere book
		Muffin tasting with and without baking powder
		pH testing activity
		Wrap-up, fun game, youth interviews
2	Fruits & Vegetables	Ice-breaker
		Finish pre-surveys
		Eat the Rainbow book
		Fruit & veggie beach ball activity
		Tie-dye shirts
		Wrap-up, youth interviews
3	Go, Slow, Woah, & Heart Health	Ice-breaker
		Go, Slow, Woah book
		MyPlate Go, Woah board game
		Heart model
		Wrap-up, fun game, youth interviews
4	Think Your Drink	Ice-breaker
		Think Your Drink book
		Calculate sugar in soda
		Sand art to represent sugar
		Wrap-up, fun game, youth interviews
5	Engineering & STEAM Careers	Ice-breaker
		Review engineer and science jobs
		Engineering food towers out of spaghetti and marshmallows
		Wrap-up, fun game, youth interviews
6	Wrap-Up & Celebration	Ice-breaker
		Jeopardy review game
		Post-surveys
		Popsicles and wrap-up

Appendix 9. Consolidated Study Timeline of Three Years of Project stRIde Programming