Combining STEM and Character Development in an Out-of-School Time Program: Participatory Practices for Developing and Validating a Theory of Change

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Abstract

Background: The goal of the study was to develop and verify a pathway model (or theory of change) for STEM Scouts, an out-of-school time (OST), positive youth development program for elementary through high school-aged youth. Pathway models include connections between hypothesized activities to short-, mid-, and long-term outcomes. STEM Scouts is offered across the United States and a secondary goal of the study was to understand the STEM ecosystem in the communities where STEM Scouts is currently implemented.

Results: Evidence mapping was conducted to determine the extent to which the theory of change was consistent with the extant literature; 69% of the connections on the key pathways were supported by research. For connections where supporting evidence was not found, the connections were either removed or retained because the connection between constructs was understudied. The literature review also led to the addition of outcomes and language revisions to more closely align with terminology used in the literature. Focus groups were conducted to determine the extent to which the pathway model was consistent with youth and adult participants' lived experience and to better understand STEM ecosystems. The pathway model resonated with most participants' experiences with STEM Scouts. Participants across multiple focus groups suggested adding outcomes related to learning and leadership. Parents and other family members, the availability of OST STEM programs, and schools were frequently noted as critical elements of the STEM ecosystem.

Conclusions: Careful evaluation planning, including the development and validation of a detailed theory of change, is a critical step in STEM education program evaluation. This study revealed the value added when such steps are taken. Critical outcomes and connections would have been missed without the development and validation of the theory of change which will form the basis of a future evaluation. OST STEM programs should strive to engage in careful and detailed evaluation planning in advance of engaging in program evaluation.

Keywords: Positive youth development, character development, youth-serving organizations, STEM interest, STEM curiosity, STEM out-of-school time, parent involvement, extracurricular activities, theory of change, evaluation

Combining STEM and Character Development in an Out-of-School Time Program: Participatory Practices for Developing and Validating a Theory of Change

In the era of COVID-19, we have learned the importance of having well-trained people working in STEM fields including the healthcare, pharmaceutical, and technological industries. However, it is not enough for these professionals to have technical knowledge; we also need them to have the social-emotional skills to engage effectively with others. This includes critical thinking, problem solving and communication skills (Gore, 2013). To ensure a future effective STEM workforce, we need to begin cultivating interest in STEM as well as the development of social-emotional skills during childhood and adolescence.

Early exposure to STEM helps youth develop academic skills in reading and math (National Research Council, 2012) and also fosters skills necessary to thrive in everyday life. Engaging in such activities helps youth build critical thinking and problem-solving skills important for learning (Alhamlan et al., 2018; Newman et al., 2015). STEM programs also have the potential to cultivate a sense of curiosity in youth (Leas et al., 2017), which may ultimately contribute to the development of their intellectual character (Ritchhart, 2002).

Providing children and youth with experiential, hands-on learning opportunities in a low-stakes setting, such as an out-of-school time (OST) program, is a promising way to engage youth in STEM. Mohr-Schroeder and colleagues (2014) found that when students attended a STEM camp with authentic, hands-on learning experiences, they developed an interest in STEM content and nearly all participants wanted to return the following year. Experimenting in an open inquiry setting improves students' knowledge (Lavie & Tal, 2015) and attitudes (Berg et al., 2003; Ornstein, 2006) about STEM. Students feel more positive and learn more about STEM when they are actively participating in an open inquiry science experiment rather than a traditional lab experiment (Berg et al., 2003). Students who are given more freedom to participate as active learners thrive in a STEM environment (Gibson & Chase, 2002; Sharkawy, 2010).

Another way to spark STEM interest is to provide youth with a safe space that emboldens them to ask questions. When students take active roles in developing their own science questions and answers, they are more engaged in the process, more motivated to learn, and expend more effort (Gibson & Chase, 2002). Encouraging students to ask investigable questions is associated with greater curiosity and better observations (Sharkawy, 2010). This emphasis on empowering youth to actively engage with their own learning process, is consistent with a positive youth development approach.

Positive Youth Development

An underlying theme across positive youth development (PYD) programs is the goal of fostering healthy or positive development among all youth (Benson, 1997; Eccles & Gootman, 2002; Lerner et al., 2013; Lerner et al., 2005). PYD programs are focused on building and enhancing youths' internal and external assets through the promotion of positive well-being across the domains of physical, intellectual, psychological, and social-emotional development (Benson, 1997; Eccles & Gootman, 2002; Roth et al., 1998). One prominent PYD framework is the 5 Cs: competence, character, caring, confidence, and connection (Lerner et al., 2005). Youth who demonstrate the 5 Cs are more likely to manifest a 6th C, contribution to self, community, and society (Lerner et al., 2005). PYD programs are generally designed to foster these attributes; youth who participate in PYD programs have improved social and emotional outcomes (Lerner & Lerner, 2013; Roth & Brooks-Gunn, 2003a, 2003b).

In recent years, the character component of the 5 Cs has received increased focus from researchers interested in positive youth development. For instance, a Relational Developmental Systems theoretical lens has been applied to the study of character (Lerner & Callina, 2017), emphasizing the role of individual agency in the development of character and potential variation in structure and function of specific character attributes across the life-span. Further, researchers and program developers interested in the development of social-emotional skills as a mechanism for promoting positive youth development have extended the scope of the oft-cited Collaborative for Academic, Social, and Emotional Learning (CASEL) five competencies–self-awareness, self-management, responsible decision making, social awareness, and relationship skills (CASEL, 2022)–to advocate for a social emotional and character development (SECD) approach to positive development (Elias, 2009). The SECD approach continues to endorse the importance of equipping youth with knowledge, skills, and attitudes to succeed–as promoted through the CASEL five competencies–but emphasizes that knowledge, skills, and attitudes should not be value-neutral and that youth greatly benefit from the explicit promotion of character virtues and development of positive purpose (Elias, 2009; Hatchimonji et al., 2018). PYD programs, in particular, have the potential to provide ripe contexts for both social-emotional and character development.

In order to have a positive effect on youth development, PYD programs must have elements of the "Big 3": (1) provide sustained and caring adult-youth relationships, (2) emphasize the development of life skills, and (3) give youth opportunities to act both as participants and leaders (Lerner, 2004). Programs that teach youth the scientific process while building life skills, such as problem solving and self-confidence, have the potential to prepare youth for a successful future, in addition to providing youth opportunities for purposeful action and thoughtful reflection. Although STEM PYD programs exist, there have not been many studies of their effectiveness. The various conceptualizations of effective PYD (Benson, 1997; Eccles & Gootman, 2002; Lerner & Lerner, 2013; Roth & Brooks-Gunn, 2003a, 2003b) and STEM programming (active and authentic hands-on learning in safe environments; Berg et al., 2003; Gibson & Chase, 2002; Mohr-Schroeder et al., 2014; Sharkawy, 2010) suggest that STEM PYD efforts may lead to fruitful outcomes for youth such as developing engaged citizens who value and utilize science in decision making. Programs that teach youth the scientific process while building life skills such as problem solving and self-confidence have the potential to prepare youth for a successful future. Such programs, however, do not exist without infrastructure. Many youth programs, STEM or otherwise, are reliant on adults to serve as leaders within these groups; sometimes these roles are filled by parents or family members of youth participants. Although this provides the opportunity for all participants to establish caring adult-youth relationships (a hallmark of PYD programs; Bowers et al., 2015), youth whose parents are involved in programming often reap additional benefits (Fan & Chen, 2001; Hara & Burke, 1998).

STEM in PYD Programs

Studies have investigated the extent to which PYD programs impact STEM learning and overall youth development. For example, youth who participate in 4-H STEM programs gain STEM academic skills and knowledge (Ripberger & Blalock, 2013) as well as opportunities to develop positive relationships with adults (Donaldson & Franck, 2020). Ripberger and Blalock (2013) found that teens who were trained to teach agricultural biotechnology in a 4-H program, gained knowledge in science content knowledge. However, relationships that were built between teens and content rich partners (e.g., adults in universities, science centers, museums, businesses) were noted as the most valuable part of the experience for them. In STEM programs, relationships with adult leaders are particularly critical for positive youth outcomes (Ehrlich et al., 2017) especially for youth who identify as female. In a study of alumni who participated in Chicago's Museum of Science and Industry PYD program, female-identifying participants reported a greater interest in STEM careers which was attributed to their perception of adult leaders as teachers or fictive kin (Price et al., 2019). These studies add to the evidence that PYD programs provide a space for youth and adults to build relationships around STEM. More research however is needed to examine how PYD STEM programs build social and emotional outcomes in youth (Martinez et al., 2014). In addition to sustained, positive relationships with adults, another hallmark of successful PYD programs is opportunities for skill-building. STEM programs are particularly well-suited to providing such opportunities to youth.

Role of Adults in Fostering STEM Learning

Teachers, parents and other adult mentors play a role in fostering STEM learning among youth. Teachers are particularly critical because they offer the most equitable form of access to STEM learning experiences, offering STEM learning opportunities to youth who may not have any other opportunities to learn or talk about STEM related topics and ideas. However, while science and math are part of every state's K-12 curriculum, every state, district, department and teacher has a unique approach to teaching STEM. Many teachers still use a didactic approach (Nie et al., 2013), with minimal opportunities for students to engage with materials or the scientific process. This approach can hinder student creativity and self-directed learning (Nie et al., 2013). While at the other end of the spectrum, many districts have fully embraced an integrated STEM curriculum (Maxwell et al., 2015), full of authentic opportunities to conduct real inquiry. This approach can foster problem solving and critical thinking skills, enabling students to take a more active role in their learning.

In addition to the important role played by teachers, parental involvement in school is widely known to positively impact youth educational and developmental trajectories (Hoover-Dempsey & Sandler, 1995; Newchurch, 2017) as well as emotional health (Wang & Sheikh-Khalil, 2014). Parental beliefs about their child's abilities influence their school achievement (e.g., Halle et al., 1997). Parents who believe their child is competent and capable of succeeding at school are more likely to have a child who holds similar beliefs. These beliefs can also positively influence the child's academic achievement (Galper et al., 1997). In the context of STEM outcomes, family can influence adolescent's STEM interest which in turn predicts STEM self-efficacy and career expectancy (Nugent et al., 2015). This is particularly the case for Black children whose parents can support their STEM identity formation by countering racist and stereotyped views (Cunningham, 2021). Research to date has addressed the influence of adults on youth outcomes including limited research on the influence of parents in the context of in-school STEM programming. However, limited research has investigated the influence that parental involvement has on youth achievement in an out-of-school time STEM program.

STEM Scouts

STEM Scouts is an OST STEM PYD program that is affiliated with Boy Scouts of America (BSA). The program officially launched in 2012 at the Great Smoky Mountain Council, and then expanded in 2015 to include 12 BSA councils across the United States. STEM Scouts serves boys and girls in elementary, middle, and high school. Youth are organized into labs of 10-20 youth that are managed by adult lab leaders who follow programmatic manuals to ensure consistent program delivery. STEM Scouts labs are organized by school level, with specific programming and lab curricula for elementary, middle, and high school-aged students. Leadership positions are rotated between scouts giving all youth an opportunity to act as leader and participant. The program offers a value-based social-emotional development program that expands STEM knowledge as it builds character, citizenship, personal fitness, and leadership. The specific goals of the program are to provide opportunities for: hands-on experimentation, developing new skills, increasing curiosity with STEM topics, discovering new career paths, and providing service to others. STEM Scouts embeds the "Big Three" features of PYD in its programming which include: opportunities for skill building; sustained, caring adult-youth relationships; and youth leadership. As a new and promising STEM OST program, STEM Scouts should be evaluated to determine its efficacy and potential for reaching a wider audience.

Theories of Change

Before initiating a programmatic study or evaluation, it is important to first define the program's theory of change. A theory of change shows how and why a program is believed to work (Weiss, 1995). Typically, logic models are used to present a visual model of a program's theory of change (McLaughlin & Jordan, 1999; Renger & Titcomb, 2002; W.K. Kellogg Foundation, 2004). Logic models are important because they lay the groundwork for evaluation and help guide decisions for the future of a program (Chen, 1990; Frechtling, 2015; Kaplan & Garrett, 2005). Pathway models are a specific type of logic model that includes boxes representing activities as well as intended short-, mid- and long-term outcomes (Trochim et al., 2012). The boxes are connected with directional arrows that indicate the causal relationship between specific activities and outcomes. The steps for developing a pathway model are outlined in the Systems Evaluation Protocol (SEP; Trochim et al., 2012; Urban, Hargraves, et al., 2021) which is a tool used when employing Relational Systems Evaluation (Urban, Archibald, et al., 2021).

Current Study

The research questions guiding this study were: 1) What is the theory of change for STEM Scouts, 2) Is the STEM Scouts theory of change consistent with the research literature, 3) Does the STEM Scouts theory of change accurately reflect the lived experiences of youth program participants and adult leaders, and 4) Within specific communities, what is the broader STEM ecosystem within which STEM Scouts is embedded?

Method

To address the research questions, a three-step process was used including: model development (RQ1), evidence mapping (RQ2), and focus groups (RQs 3 and 4). A working group was convened consisting of representatives from the national BSA STEM Scouts office (including the original program developers), as well as researchers with expertise in character development, OST programs, and STEM education.

Model Development

The nine-member working group met in person over two days to create the STEM Scouts pathway model.

Figure 1. Building a Pathway Model

Note. The image is an example of the Pathway Model building process and is not the model for STEM Scouts.

This process began by brainstorming the activities that comprise STEM Scouts. Next, the group brainstormed outcomes that can be plausibly derived from the set of agreed upon activities. These outcomes are then arranged spatially so that the shortest-term outcomes (outcomes that occur as a direct and/or immediate result of the activities) are placed closest to the outcomes from which they are derived, the subsequent or mid-term outcomes are placed next and the longest-term outcomes are placed last. Finally, the outcomes are linked by arrows that demonstrate the theoretical causal or contributive relationship between the activities, short- mid- and long-term outcomes. Because the process does not restrict the group to one-to-one relationships between nodes, or a columnar formation, the resulting image has an organic feel and shape, with arrows converging and diverging around key

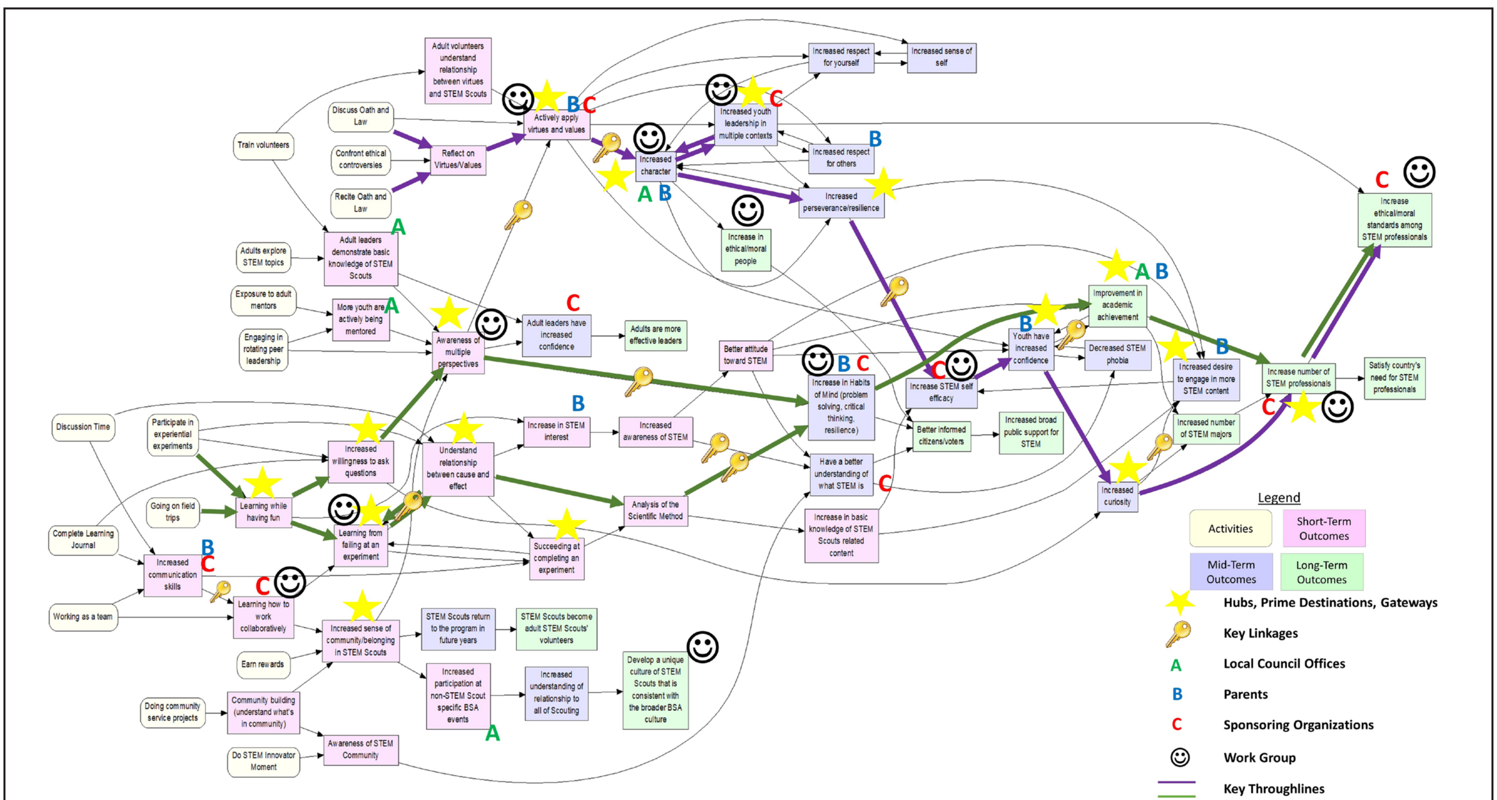


Figure 2. Original STEM Scouts Pathway Model with "Mining the Model" Completed

Note. The green (STEM academic) and purple (character building) pathways emerged after the working group developed the model. These two pathways guided the evidence mapping process.

Focus Group #	Adult Participants	Youth Participants	Region	Additional Descriptive Information
1	2 adult volunteer leaders	1	Western	Adults were from different STEM Scouts labs that served youth with different SES backgrounds.
2	1 BSA Council staff 1 adult volunteer leader	0	Southern	
3	3 adult volunteer leaders 1 parent volunteer	1	Central	Youth was middle school-aged.
4	4 parent volunteers	6	Northeastern	Youth were high school-aged. 2 parents were STEM professionals.
5	1 BSA Council staff 10 parent volunteers	11	Northeastern	Youth were elementary school-aged and came from a variety of school settings, including public, STEM focused, Montessori, and homeschool. Focus groups were divided into a youth group and an adult group, each run by a different facilitator.

Table 1. Sample Descriptive Information

outcomes, and culminating in an arrowhead on the right, representing the ultimate intended outcome(s) of the program. See Figure 1 for an image of a working group building a Pathway Model.

Once the paper draft of the model was complete, the information was entered into the Netway, a free online platform for developing pathway models and evaluation plans (www.evaluationnetway.com). The working group then engaged in an activity called "mining the model" whereby key outcomes, linkages, and stakeholder priorities are identified. Based on this information, the key pathways are identified in the model.

Focus Groups

Focus groups were conducted with STEM Scouts youth and adult participants across the United States. Participants were asked whether the model resonated with their experiences as adult volunteers or youth members of the program.

Sample

The STEM Scouts executive director from the national office provided the research team with contact information for directors of local councils that were implementing STEM Scouts. The aim was to recruit 4 to 5 councils from diverse geographic locations. Researchers purposively selected potential councils by first confirming that: 1) the council had an active STEM Scouts program; 2) the council had more than one active lab; and 3) the council was not just beginning its STEM Scouts program. A member of the research team reached out to local councils through phone and email communications to invite them to participate in focus groups. Council executives who were interested in participating emailed STEM Scouts lab leaders to assess whether parents and youth would like to participate. Those that agreed to move forward with the study were provided with consent forms prior to the focus group. As an incentive, each adult participant was given a $25 gift card and each youth participant was given a $20 gift card.

The research team conducted a total of five focus groups with STEM Scouts adult leaders, volunteers, and youth in Connecticut, New Jersey, Tennessee, Colorado, and Indiana. A total of 19 youth and 23 adult volunteers participated. Focus groups ranged in size from zero to 11 youth ($M = 3.80$; sd=4.66) and two to ten adults ($M = 4.60$; sd=3.71). Participants also ranged in grade level from elementary school to middle and high school. Additional information about the sample is provided in Table 1.

Procedure

Focus groups were held in schools or in BSA council offices; they were audio recorded and lasted approximately one hour. Parents, adult participants, and youth completed consent and assent forms prior to participating. The facilitator described the purpose of the focus group, focus group norms, and rights of the participants. In the first activity, the facilitator explained what a pathway model is and then each participant was given their own placemat-sized version of the pathway model, a marker, and a set of stickers. Participants were asked to look through the model, to mark the most important outcomes with a star sticker, to mark the most important links between outcomes/activities with a key sticker, to suggest whether there were any missing elements in the model or to suggest if anything needed to be modified based on their own experience of the program. Participants were also asked whether the model made sense to them, whether they could understand all of the terms used in the model, and whether any elements of the model were confusing. This was followed by a discussion elaborating on how participants modified their individual pathway models.

To address Research Question 4, a STEM ecosystem activity was implemented to enhance knowledge about the extent of available STEM resources and experiences in scout communities. Participants were asked to create drawings of their local STEM ecosystem. First, the facilitator provided an example of a youth ecosystem diagram on an unrelated topic in order to provide an example of how the diagram should work. After participants drew their own maps of their STEM Scouts ecosystem, they were then asked to share their drawings prompting discussions about the local accessibility of STEM programming beyond the STEM Scouts program.

Analysis

Focus group facilitators took pictures of the participants' modified pathway models. Two members of the research team tallied the suggested revisions, star stickers, and key stickers. The research team summarized the notes from the focus group discussions and reviewed them alongside the tallies. Two members of the research team used a priori codes to analyze the focus group notes. These included: Suggested Changes, Experiences in STEM Scouts, and Most Important Aspects of the Pathway Model. A consensus approach was then used to conduct a second round of sub-coding for the "Suggested Changes" code. Suggestions were coded as Remove (referring to a node or link), Maybe Consider, or Definitely Consider. For example, feedback was coded as Remove when a connection already existed on the pathway model or a connection was found to be a leap in logic; feedback was coded as Definitely Consider when a participant suggested a new node or connection that could potentially improve the pathway model. The project PIs reviewed the coding prior to presenting the findings to the working group.

Facilitators collected Ecosystem Maps at the end of the focus groups and the research team reviewed and summarized audio recordings of discussions. Researchers analyzed pictures of participants' ecosystem maps and created a coding dictionary for classifying STEM themes (i.e., school, educational games, OST STEM programs). Two coders independently analyzed pictures drawn by participants and tallied the total number of times each theme was drawn for each focus group location. Data were separately summarized for each focus group to indicate the number of times each theme was present. The inter-rater reliability was 100% after the first round of coding.

Evidence Mapping

Evidence mapping was conducted after the focus groups were completed. A team of researchers conducted a literature search to confirm the extent to which the key pathways on the pathway model were consistent with current research. Each of the links between nodes on the key pathways was listed; a search of the peer-reviewed literature was conducted to determine whether there was support for the links. Studies used as evidence to support components of the pathway model were provided by two content area experts (one a STEM education expert and the other a youth development, character and OST programs expert). The most important criteria for determining whether a study was relevant was the study's alignment to the constructs and logic in the pathway model. For example, when looking for evidence to support the connection between "Increased willingness to ask questions" and "Awareness of multiple perspectives," only studies that directly addressed the relationship between asking questions and awareness of multiple perspectives were included. Studies about the importance of asking questions but not about how this relates to perspective-taking would not be included. This level of specificity accounted for the relatively low number of studies used to support each link. Studies were not explicitly limited by OST/non-OST, age level or time span.

For each link, a list of relevant citations was created as well as a summary of the findings for the link. Each reference was then given a score reflecting the strength of that article's support for the link (0=none, 1=low, 2=low/moderate, 3=moderate, 4=moderate/high, 5=high). The total score for each link was described as the proportion of the total possible score (number of references x 5) reached by combining the assigned scores for all of the references related to that link. The highest score given to a link in the model was 18/20. The lowest was 0/0 (no references found). The working group met to review the findings from both the evidence mapping and the focus groups and decided which nodes and links needed to be revised, deleted, or added.

Results

Model Development

The in-person meeting resulted in the first draft of the Pathway Model for STEM Scouts (Figure 2). The model included two key pathways: one pathway representing building youth character and the other STEM skills.

Evidence Mapping

Evidence mapping revealed 69% of the connections on the key pathways were supported by evidence in the research literature; this means that for 69% of the links, the researchers were able to find published studies that supported the presence of a connection between the two very specific constructs relevant to that link. For connections where supporting evidence was not found (31% of the links), the working group discussed whether or not to change the model. This decision-making process was critical to the further development of the model. Ultimately, the model should represent how key stakeholders (in this case the working group) believe their program works. As a theory of change, the pathway model should not be understood solely as a summary of the already available evidence related to a particular set of activities or constructs. Instead, the pathway model has the power to represent a convergence of different ways of understanding how a program works–what the literature says, what the program developers say and what various other stakeholders say. It is the job of the facilitator to assist in the balancing of these perspectives. The facilitator poses critical questions, reminds the working group of other available views or sources of evidence and generally prompts thinking and decision making. Ultimately, however, the working group members are the authors of the model. Their ownership of the model is critically important to the success of the model as a planning and evaluation tool. And, as owners of the model, it is also the responsibility of the working group to continue to reflect, seek additional evidence, and revise the model over time.

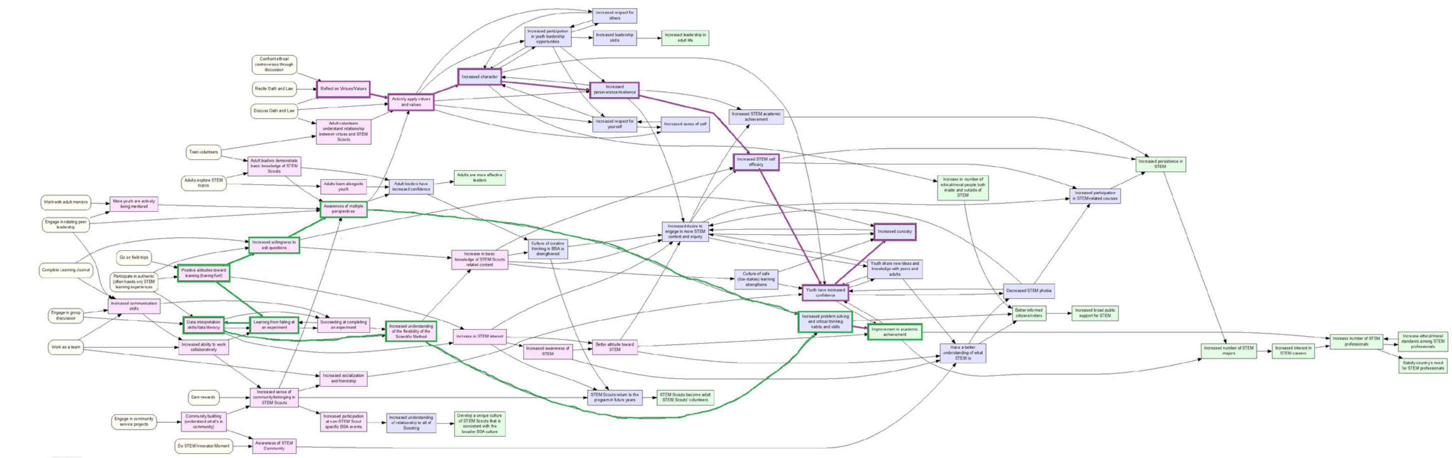
In some cases, the group decided to retain a pathway connection even though no published studies had been found to support the relationship between the two specific constructs. For example, we did not find evidence to support the connection between: "Youth have increased confidence" and "Increased curiosity." The working group decided to keep this connection because of its relevance to the STEM Scouts experience. Similarly, the connection between "Understanding the relationship between cause and effect" and "Learning from failing" was not found in the literature. In this case, the decision was to revise the language from "Understanding the relationship between cause and effect" to "Data interpretation skills/data literacy." The revised outcome more closely aligned with the terminology used in the literature and still conveyed the intended meaning. This revision also helped to clarify overlapping constructs. "Understanding the relationship between cause and effect" and "Analysis of the scientific method," were too similar to be meaningfully distinguished. "Analysis of the scientific method" was changed to "Increased understanding of the flexibility of the scientific method" to distinguish more between the two outcomes.

The review of the literature led to the addition of several outcomes, including: "Increased persistence in STEM," "Increased interest in STEM careers," and "Increased STEM academic achievement." Evidence mapping also identified "leaps in logic." For example, the original model had a direct connection between "Increased curiosity" and "Increased number of STEM professionals." The working group decided to remove this direct connection and added mid-term outcomes between them. In the revised pathway model, the pathway now goes from "Increased curiosity" to "Increased desire to engage in more STEM content and inquiry" to "Youth share new ideas and knowledge with peers and adults" to "Youth have increased confidence" to "Improvement in academic achievement" to "Increased number of STEM majors" to "Increased interest in STEM careers" to "Increased number of STEM professionals."

Focus Groups

Pathway Model

The pathway model resonated with most focus group participants' experiences with STEM Scouts. Participants across focus groups selected a variety of outcomes (e.g., pathway model nodes) as important to the STEM Scouts experience. These data were tallied across all focus groups. Participants particularly valued STEM Scouts outcomes related to learning (18), habits of mind (14), and increased ethical behavior/character (9). Three of the four most frequently noted outcomes were on a key pathway: "problem solving & critical thinking skills" (n=14), "learning while having fun" (n=9), and "learning from failure" (n=5). Five participants noted each of the following outcomes that were not on one of the key pathways: "increased ethical and moral people" and "learning how to work collaboratively." Focus group participants were also asked to select the most important connections (links) between activities/outcomes (nodes). The most commonly noted links were: "Increased willingness to ask questions ➔ Increased curiosity" (n=5), "Actively apply virtues and values ➔ Increased character" (n=4), "Awareness of STEM community ➔ Have a better understanding of what



Note. The green highlighted key pathway, which diverges into two sub-themes before re-converging, represents the academic path and the purple line represents the character building path.

Figure 3. Revised STEM Scouts Pathway Model Following Evidence Mapping and Focus Groups

STEM is" (n=4), "Awareness of multiple perspectives → Increase in habits of mind" (n=4), "Learning from failing at an experiment → Understand relationship between cause and effect" (n=3), and "Understand relationship between cause and effect → Analysis of Scientific method" (n=3).

The feedback from the focus groups was summarized and shared with the STEM Scouts working group. The working group systematically went through each suggestion and reached consensus on whether the change should be made to the pathway model. Although most feedback from focus group participants was unique, suggestions related to learning and leadership emerged across multiple focus group participants. Based on these suggestions, the working group decided to add the following leadership outcomes to the pathway model: "Increased participation in youth leadership opportunities," "Increased leadership skills," and "Increased leadership in adult life." The following learning outcomes were also added to the pathway model: "Taking more STEM related courses," "Culture of creative thinking in BSA is strengthened," "Culture of safe (low-stakes) learning strengthens," "Adults learn alongside youth," and "Youth share new ideas and knowledge with peers and adults." The outcome "Increased socialization and friendship" was also added based on focus group feedback.

Based on the recommendations derived from evidence mapping and the focus groups, the pathway model was revised (Figure 3) to be more consistent with both the literature and the STEM Scouts experience.

STEM Ecosystems

The ecosystem maps were analyzed separately by geographic location to assess the extent to which STEM is available for scouts in each community.

Focus Group 1. In their ecosystem drawings, all participants included peers and family members as factors that influence STEM involvement. Both adults identified access to tangible resources in the community in their drawings. Participants also discussed barriers and enablers of STEM participation. Geographic location of STEM activities was considered a potential barrier to youth access to STEM programming, while accessibility of transportation and availability of school grounds for hosting STEM programs were identified as enablers of out-of-school time STEM programming. Participants' models indicated that parents served as a major factor in their children's access to STEM. When parents wanted their youth to be involved in STEM, children were more likely to engage in it. STEM interest was also influenced by the peer subculture surrounding education. Peers who valued education potentially influenced further interest in STEM. One STEM Scouts leader also indicated that youth in his lab come from an impoverished community and having STEM knowledge made them feel special because they were viewed as experts in STEM by their peers and community.

Focus Group 2. Both participants included school/family and community as influences in their STEM ecosystems. Participants noted there are many people with social capital (e.g., one participant mentioned "250 of the most powerful men and women in our city") who are directly linked with and have a vested interest in STEM Scouts' success and had a specific motivation to serve youth in the community. In this geographic area, STEM Scouts includes youth from diverse socioeconomic and racial/ethnic backgrounds, sometimes together in the same lab; this diversity in STEM Scouts membership was unique to this location.

Focus Group 3. In their STEM Ecosystem drawings, school was included by four adult participants, home/parents were included by three, and extracurricular activities were included by two participants. The maps and discussion highlighted the many opportunities to access STEM including through extracurricular programs such as robotics and Lego camps. However, participants felt there was not enough programming for younger children. This was in contrast to middle school-aged youth where the sentiment was that youth experienced STEM overload. One adult mentioned that approximately two-thirds of youth in their lab did not want to be involved in an out-of-school STEM program, but their parents insisted they participate. Participants described a mix of parents who were involved in the running of the lab and parents who just dropped their children off at the program. Lab leaders indicated it was difficult to engage busy parents who expected schools to be responsible for teaching STEM and building youth character.

Focus Group 4. In their ecosystem drawings, eight participants included school, seven included media/technology/internet, six included family members, and four included extracurricular activities. In the STEM ecosystem discussion, participants noted that in school, STEM content is sometimes outdated and the focus is largely on testing and memorization. They shared that parents of peers in their school did not always see value in STEM. Youth participants also noted that opinions about STEM in the community are neutral or slightly negative. This was in contrast to the STEM Scouts parent volunteers who were very involved in their children's STEM experiences.

Focus Group 5. In their ecosystem maps, six participants included family involvement, six included extracurricular STEM activities, six included media/technology, and four included school. There were different levels of access to STEM at home including weekly conversations with parents about STEM related questions, STEM toys/kits, and exposure to STEM media content (e.g., documentaries, coding programs such as MIT Scratch, computer games such as Prodigy, and STEM Books about topics such as maker space). Similar to Focus Group 4, many of the parents in this group were also STEM professionals. Parent involvement was mandatory for the lab and adults took turns taking on leadership roles. Adults discussed how garnering excitement for STEM within the community was difficult particularly because the surrounding town was considered sports-centric. Even though resources such as science centers, museums and fairs were available within the community, getting families excited about STEM was still difficult because most families would still prioritize sports over STEM activities. The families that did participate in STEM Scouts valued STEM and utilized the available local resources but indicated that others within the community did not have the same mentality. Many parents/volunteers were themselves in STEM occupations and it was evident that they wanted to pass along those values to the youth. However, there was a lack of STEM education at the 3rd and 4th grade levels in the public school. A few similarly aged youth enrolled in the public school noted STEM classes were scheduled once a month (or less often) and were disheartened it was so infrequent. Parents concluded that the pipeline for STEM professionals is starting too late.

Comparative Analysis. A comparative analysis of the STEM ecosystem maps across the five focus groups revealed several themes. First, the important role parents and other family members play in fostering STEM was consistently noted. The availability of extracurricular activities outside of STEM Scouts such as clubs and camps were also considered important factors in the STEM ecosystem. Participants in all five groups emphasized the role of school as an avenue for accessing STEM content. In some cases, schools were failing to meet the STEM needs of students. While some schools did not offer enough STEM, other schools focused almost exclusively on memorization and testing of STEM content. However, schools are also a potential source of support for OST STEM programming. For example, participants in three of the focus groups used school facilities to host their STEM Scouts lab after-school. Across all of the focus groups, STEM Scouts seemed to serve an important role in youth learning outcomes, particularly for youth without access to STEM at school. STEM Scouts, and other programs like it, could potentially address the lack of STEM learning opportunities in some communities.

Discussion

This study used a multi-stakeholder process that incorporated both lived experiences and research evidence in the development and validation of a detailed programmatic theory of change. Although the original pathway model resonated with adult and youth participants, they did note important missing outcomes such as leadership, low-stakes learning, creative thinking, and increased opportunities for socialization and friendship. Additionally, evidence mapping identified several prominent constructs in the literature that were missing from the model, including persistence, STEM interest, and achievement. Discussions with participants highlighted the perceived impact of parental involvement on youth STEM Scouts experiences. The ecosystem activity also echoed the notion of the importance of parental involvement, as participants consistently indicated that family and school were the two most important links to how youth access STEM.

Two key outcomes identified as important by many STEM Scouts participants in their review of the pathway model were "increased ethical behavior and character" and "learning how to work collaboratively with others". PYD programs often prioritize helping youth build character by providing opportunities to foster prosocial behavior and civic engagement (Hilliard et al., 2014). In a meta-analysis, Durlak and Weissberg (2007) found after school programs that focus on improving youths' personal and social development have a positive impact on prosocial behaviors including increased ethical behavior. In a national study of 158 STEM after school programs, strong correlations were found between STEM programs and social-emotional outcomes including critical thinking, perseverance and relationship building with adults and peers (Allen et al., 2019). In a study of a 4-H science initiative, participants indicated the best part of the program was the relationships built and positive experiences they had with peers and adults (Mielke & Butler, 2013). The current study also affirms the importance of incorporating social-emotional and character development goals in STEM OST programs.

The significance of parent/family involvement in STEM activities was noted in the focus groups and confirmed by evidence mapping. Parents who are invested in youth outcomes play a pivotal role in helping youth thrive and are particularly important in helping promote positive youth outcomes (Bowers et al., 2015; Theokas & Lerner, 2006). Parents can serve as a resource in PYD programs by supporting their children in learning beyond the program (Bowers et al., 2015). Although not as much research has shown the impact that parental involvement has on STEM in PYD programs, some research has shown the positive impact this involvement has on math achievement (Yan & Lin, 2005) and problem solving skills (Topor et al., 2010).

Another key feature of STEM Scouts highlighted by focus group participants is the opportunity to learn in a safe space that allows for failure, which ultimately promotes habits of mind. Habits of mind were identified as a key outcome of STEM Scouts. Although habits of mind covers a broad range of skills (e.g., questioning and posing problems, applying past knowledge to new situations, taking possible risks, curiosity, communication; Costa & Kallick, 2008), utilizing these habits is necessary for practicing scientific research and should be applied to STEM learning (Volkman & Eichinger, 1999). BSA has created a culture that embraces failure as part of the learning process. Working without fear of failure provides an opportunity to be creative (Tahirsylaj, 2012) and failure itself is an integral part of the learning process. Simpson and Maltese (2017) interviewed STEM professionals as adults and found that failure was a necessary part of their life trajectory and helped them become successful. Environments that cultivate experiencing failure are particularly important in youth STEM programs as failure often stimulates perseverance (Dickson et al., 2021), creativity (Trninic et al., 2018), and critical reflection which are important for uncovering key concepts and effective problem solving (Jackson et al., 2021). STEM Scouts is unique in that cultivating failure is done explicitly within the context of a program that simultaneously and explicitly promotes the development of character attributes such as perseverance and curiosity.

The ecosystem activity exposed school and home as two key environments that enable STEM accessibility. This finding is consistent with expectancy value theory, which posits that success or achievement is shaped by a variety of factors (including the environment) that work together (Ball et al., 2017). Those who subscribe to expectancy value models of achievement theorize that achievement-related choices and future aspirations are heavily influenced by abilities, perceptions of competencies, and values (Eccles et al., 1983; Eccles & Harold, 1991); Wigfield et al., 2017). In short, achievement-related choices are believed to manifest in a cyclical manner whereby one's previous achievement-related choices and performance within specific contexts help inform and predict future achievement-related behaviors (Eccles et al., 1983). In programs such as STEM Scouts, parents, adult volunteers, and educators can work together to foster success in youth and help them thrive by providing supportive and responsive learning contexts where youth develop positive associations through their learning experiences (i.e., accepting failure as part of the learning process, contributing to the development of habits of mind and character).

Implications

Our findings are grounded in the perspectives of those who most closely engage with STEM Scouts including adult leaders and youth participants. The inclusion of stakeholder voices in the development of programmatic theories of change is critical to achieving high quality evaluation (Chauveron et al., 2021). Relational Systems Evaluation and the Systems Evaluation Protocol are grounded in research-practice partnerships that elevate typically under-valued perspectives (Buckley et al., 2021). The original version of the pathway model was developed with STEM Scouts leadership and subsequently validated and edited based on findings from evidence mapping and focus groups. A triangulated approach to research-practice integration holds promise for the potential utility and quality of future evaluation work. Indeed, this relational approach will be applied in a future evaluation of STEM Scouts that will be grounded in the pathway model. Other STEM OST programs are encouraged to incorporate a relational approach such as Relational Systems Evaluation when developing and testing programmatic theories of change.

Limitations

The generalizability of the study results is limited by the small sample size. Members of the labs included in the focus groups may not be representative of most STEM Scouts labs. For example, two of the focus groups included participants from a community of highly involved parents. These communities may have additional resources, and parents or other volunteers may have more free time to be involved with STEM Scouts. Furthermore, we only heard the perspective from groups that agreed to participate in the study. Responses may have varied had we included former members of currently inactive labs or members of newly formed labs. Another limitation is that the elementary school-aged youth were not able to provide as many comments on the pathway model since it was difficult for them to understand.

Conclusion

Careful evaluation planning, including the development of a detailed theory of change, is a critical step in STEM education program evaluation. STEM program evaluations are more likely to be relevant and useful if they are grounded in both research and participant experience (Urban & Trochim, 2009). This study revealed the value added when such steps are taken. Critical outcomes and connections would have been missed without the development and validation of the theory of change which will form the basis of a future evaluation. OST STEM programs should strive to engage in careful and detailed evaluation planning in advance of engaging in program evaluation.

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