



MILLION GIRLS MOONSHOT

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# Go the Distance: A case study review of out-of-school time programs & youth impacted by the Million Girls Moonshot



December 2022

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In fall 2020, STEM Next Opportunity Fund launched the Million Girls Moonshot (MGM) Initiative, a nationwide out-of-school time (OST) effort aimed to inspire and prepare the next generation of innovators by engaging one million more girls in STEM learning opportunities that help them develop an engineering mindset. MGM supports the 50 State Afterschool Network to guide youth-serving organizations within their states by providing professional development and technical assistance to implement the Transformative Practices that engage girls in STEM.

**MILLION GIRLS MOONSHOT  
 TRANSFORMATIVE PRACTICES**

The four Transformative Practice areas below are research-based strategies shown to effectively engage girls and marginalized youth in STEM:

**Engineering mindset** – activities that engage girls in developing a set of ten skills and attitudes including using math and science, iteration, persistence, teamwork, and envisioning multiple solutions.

**Inclusive and equitable STEM** – practices that encourage girls and marginalized youth to engage in STEM, including selecting topics of interest to all genders, incorporating community issues into activities, and working in cooperative groups.

**Role models, mentors, and families** – engaging young people with STEM professionals from underrepresented backgrounds and encouraging families to participate in STEM activities together.

**Continuous STEM learning pathways** – working across programs and organizations to assure that young people who are interested in additional STEM-related activities experience a “warm hand-off” between experiences.

# MILLION GIRLS MOONSHOT THEORY OF ACTION

The Moonshot Theory of Action, depicted in Figure 1, describes a sequence of interconnected steps that can result in the achievement of the Moonshot Initiative's major goals:

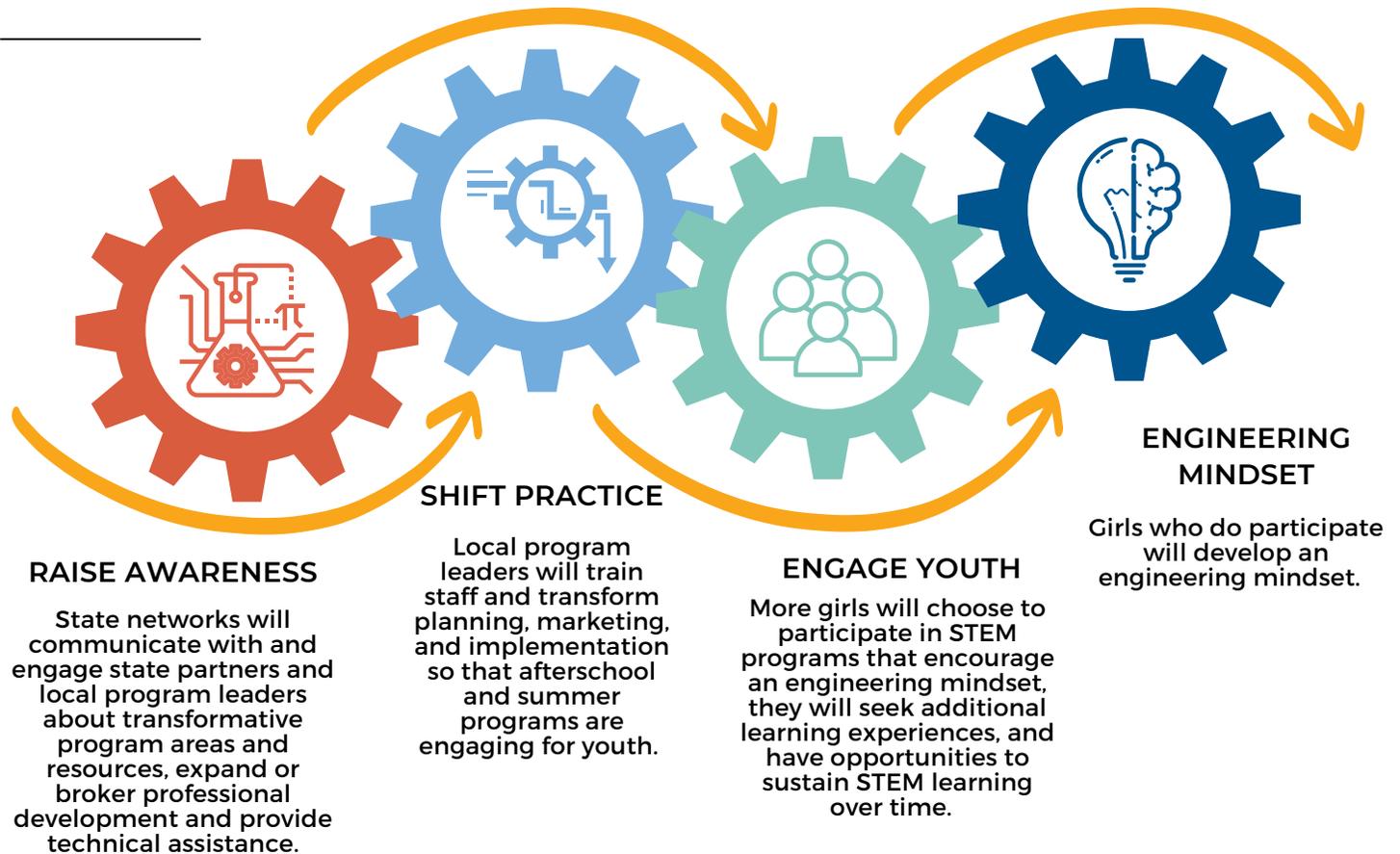


Figure 1: Million Girls Moonshot Theory of Action

1. **Build capacity and raise awareness** of state leaders to provide the support needed to youth-serving programs in their states and engage new partners to help with the Initiative.
2. **Shift Practice** by supporting local programs to adopt transformative practices through professional development and technical assistance.
3. **Engage youth in STEM** through welcoming marketing, engaging programming, and multiple opportunities to sustain their interests over time.
4. **Foster engineering mindset** among girls, non-binary youth, and other underrepresented young people.

Four Case Studies described within this report were commissioned in Year One of the Million Girls Moonshot to learn how affiliated OST programs were helping youth foster an engineering mindset. Research teams found that case study programs implemented MGM's four transformative practices through a variety of approaches, and youth were engaged in the critical thinking and problem solving activities their leaders provided for them. Though data collection was limited in this first year of the initiative, findings suggest youth were developing attitudes about STEM and about themselves that are essential aspects of an engineering mindset.

# EVALUATING THE MILLION GIRLS MOONSHOT INITIATIVE

The Moonshot initiative is evaluated to ensure youth are positively impacted by the Transformative Practices and grantees are aligning their efforts with the Theory of Action.

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## ANNUAL REPORT

The MGM's evaluation team, Public Profit, authors an annual report that shares the initiative's progress toward its goals. The first Annual Report focused on the first two phases of the Theory of Action in the initiative's infancy: 1) building capacity and raising awareness of state leaders; and 2) shifting practice of local programs. The report relied on data provided by the 50 Afterschool State Network leaders and a survey of local program leaders. The goal of that effort was to cast a broad net to learn about the impact of the initiative from as many Network and program leaders as possible.

## CASE STUDIES

As a complement to the evaluation of the MGM Initiative, STEM Next Opportunity Fund commissioned four case studies in Year One of the initiative (2020-2021) to examine what the initiative looks like "on the ground," where local organizations influenced by the MGM Initiative are working to implement transformative practices. The case studies aim for a narrower but deeper understanding of the MGM's impact on local leaders and youth, with emphasis on the second, third, and fourth phases of the Theory of Action.

In contrast to the Annual Report's quantitative analysis of the initiative's national scope, the data retrieved from case studies is predominantly qualitative, which involves meaningful interviews with program leaders and detailed observations of OST instructional activities. The four case studies were conducted by three teams from [ACRES](#), [PEAR](#), and [Public Profit](#). Two of the case studies were conducted during the pandemic which limited the number of youth served and the ability to administer all of the instruments fully, and all four case studies had limitations. That said, the four case studies together paint a vivid picture of how transformative practices are being implemented with OST youth.

## THIS REPORT SYNTHESIZES FINDINGS FROM THE FOLLOWING CASE STUDIES.

- Linking Engineering to Life: Village of Essex Junction, Vermont
- LearningWorks: Caterboro, Maine
- Oregon Tribal Youth Center: Myrtle Creek, Oregon
- North Platte Kids Klub: North Platte, Nebraska

This synthesis begins with an overview of each case study, followed by a comparison of how each of the organizations implemented MGM's Transformative Practices. The report then summarizes three instruments being used to measure the quality of instruction and the youths' development of an engineering mindset. The purpose of this document is not to compare the four programs, but rather to illustrate a variety of different ways that transformative practices are being implemented, and how success can be measured.

# PART 1. OVERVIEW OF CASE STUDY SITES

## Linking Engineering to Life: Village of Essex Junction, Vermont

### PROGRAM OVERVIEW

Link Engineering to Life (LEL), based on a curriculum from Vermont Afterschool Inc., aims to “eliminate barriers to involvement such as access to technology, transportation, gender and racial identity, economic disparity, learning styles and geographic location in Vermont.” Instruction was designed to be flexible for in-person, virtual or hybrid implementation during the pandemic. The program required only a nominal charge for materials.

The Essex Junction program, which took place in November 2020 through March 2021, was one of thirteen LEL programs held at different sites around the state of Vermont.

### PARTICIPANTS

Essex Junction Recreation and Parks (EJRP) is a municipal service department that employs 21 staff and serves more than 1,000 children from preschool through 8th grade each year. The observed OST enrichment program engaged 8 girls in the case study. These youth had started with the program in November 2019 and were familiar with the curriculum and experience.

### LEARNING EXPERIENCES

The case study team virtually observed two engineering-based activities from the EJRP LEL program in March 2021.

In Part 1 of the program the youth learned about the engineering design process through hands-on activities including designing a bandage that can hold a given volume of blood, designing safety features to protect passengers during a car crash, and more. In Part 2 of the program the girls worked on a project that they selected—designing and testing a filtration device for dirty water.

At the conclusion of the LEL program all youth, staff and mentors gathered on Zoom to celebrate and share videos of their culminating projects. Their recorded videos showed how the team defined the dirty water problem, imagined how it might be solved, commented on each other’s plans, then tested and improved their designs. The youth also had an opportunity to discuss their LEL experience with four state legislators and describe their use of the engineering design process and how they addressed challenges they encountered.



Youth Engaged with Part 1 of Link Engineering to Life

# LearningWorks: Waterboro, Maine

## PROGRAM OVERVIEW

LearningWorks is a 21st Century Community Learning Center that aims to reimagine learning through innovative programs that help children, adults, and families realize their potential and build thriving communities. Through extensive training and collaboration with ACRES and other partners, staff at LearningWorks have learned how to create an inclusive environment for girls to participate in STEM and adopt an engineering mindset.

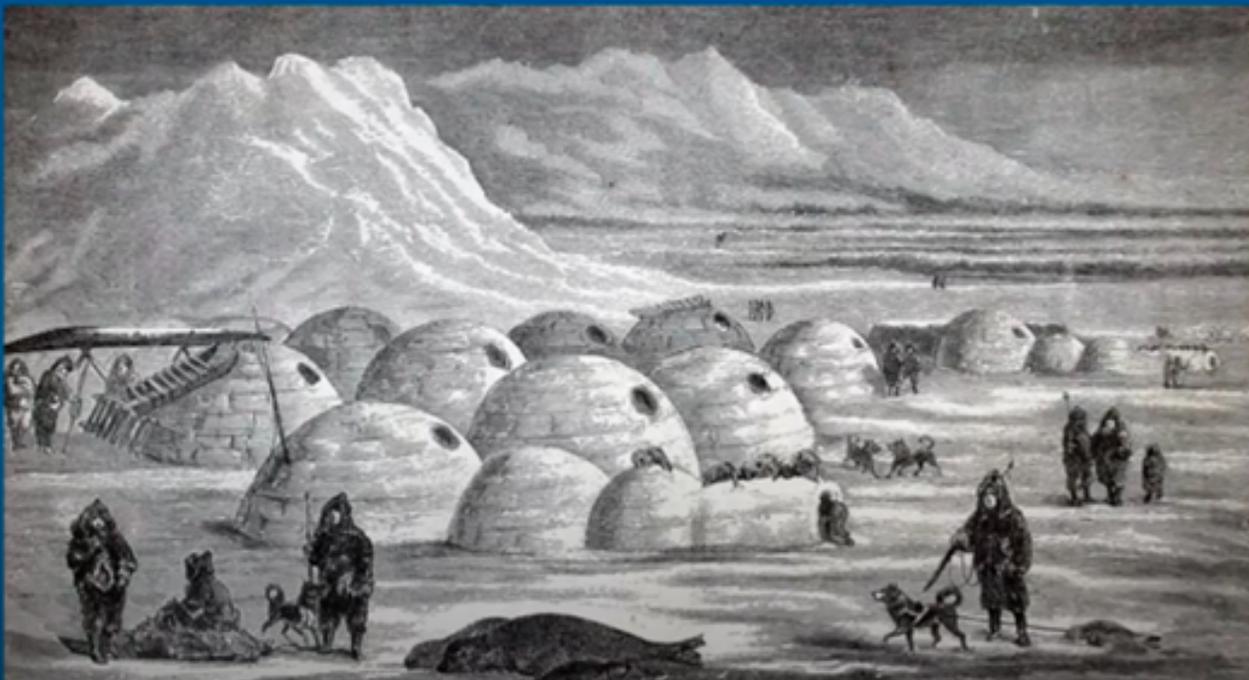
## PARTICIPANTS

Each year, LearningWorks serves 3,000 individuals across 47 towns in Southern Maine, including afterschool programs that serve children in Pre-K through 5th grade. This case study focused on a LearningWorks afterschool program in Waterboro, Maine, attended by four girls and two boys.

## LEARNING EXPERIENCES

Due to the pandemic, the LearningWorks program was presented virtually and the case study research team remotely observed and rated four pre-recorded sessions of the learning experience. Instructional materials had been dropped off at the homes of children by staff, which often provided an opportunity for an informal, socially distanced meeting.

The curriculum for these sessions was Designing Igloos: Warm Homes for the Inuits, adapted from Engineering Is Elementary, created by the Museum of Science, Boston. Through a four session unit, children were challenged to design an igloo that was large enough to accommodate the photograph of an Inuit family, using only the materials that were dropped at their home. Each lesson was carefully planned, and materials were chosen to ensure that women and girls are not depicted in stereotypical gender roles.



Youth Engaged in LearningWorks Virtual Activity

# Oregon Tribal Youth Center, Myrtle Creek, Oregon

## PROGRAM OVERVIEW

The Oregon Tribal Youth Center serves Indigenous youth from the local tribal community and affiliated tribes and is one of the only afterschool programs in the county. In addition to STEM programming, it provides meals and transports students from school to the program location, which can take over an hour one-way.

The youth center is stocked with state-of-the-art equipment, such as 3D printers and laser cutters, that offer hands-on opportunities to engage with new technologies and STEM concepts. Staff take a youth-centric approach, encouraging youth leadership, voice, and choice. Staff frequently bring in tribal role models who help youth connect program activities to other settings, creating relevance for the concepts they learn. Further, the entire program has a sustained focus through a culturally responsive curriculum.

## PARTICIPANTS

Staff access the tribal registry and personally call tribal families to recruit and engage youth starting in preschool. Center staff focus on retaining youth as they grow by adapting programming for them and exploring new age-appropriate projects. The afterschool STEM program serves up to 32 youth and is open to youth in 3rd-12th grades. Ten elementary and middle school-aged youth participate consistently, including the 9 involved in the session observed by the research team.

## LEARNING EXPERIENCES

Scheduling challenges allowed for only one class session observation, in which nine youth had an opportunity to use a new laser cutter. The facilitator started the activity with a variety of materials to cut including sheets of wood, acrylic, and leather. Youth gathered watching while the machine cut their designs that later were built into a final product.

Throughout the activity, the relationships between the facilitator and the youth, and among the youth, were positive and equitable. The facilitator seamlessly shifted back-and-forth from supporting youth at the laser cutter to those already building their cutout designs. She asked questions about their thinking or the progress they were making with a genuine caring and interest that she shared equally with all youth present.



Youth engaged in Design & Creation with their Classroom Laser Cutter

# North Platte Kids Klub, North Platte, Nebraska

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## PROGRAM OVERVIEW

The North Platte Kids Klub (NPKK) is a free school-based summer and afterschool program staffed by school district teachers and paraprofessionals. NPKK's eight-week summer program serves youth from seven area elementary schools providing academic instruction, enrichment activities, STEM programming, and on-site meals. With over half of students qualifying for free or reduced-price lunch, NPKK provides an essential service in the region as the only school-based afterschool program provider in the county.

## PARTICIPANTS

NPKK typically serves 175 kindergarten to fifth grade youth during their summer program across 7 schools, though enrollment was capped at 145 in 2021 to provide safe in-person instruction due to COVID-19. Research observations involved 15 fourth and fifth grade youth on day 1, and 6 upper elementary youth on day 2.

## LEARNING EXPERIENCES

On a typical summer day at NPKK, the morning emphasizes learning across science, technology, math, and language arts, while afternoons offer hands-on enrichment, recreational activities, and field trips. This case study included a 2-day observation of two activities: building solar ovens on day 1 and testing simple circuits with Makey Makey kits on day 2.<sup>1</sup>

The goal of the solar oven lesson was to design and construct the oven to then bring outside to cook s'mores in the summer sun. The facilitator began with a large group discussion about the purpose of each component of the oven, and the youth then led the design and construction process, with most getting an opportunity to actively assist with taping and application of materials. In just twenty minutes, each group crafted the simple oven prototype, which they brought outdoors for testing and further discussion.

The next day, 3 pairs of youth were equipped with a laptop and a Makey Makey kit, an invention kit with a circuit board, alligator clips and a USB cable that is designed to connect everyday objects to computer keys to create closed loop electrical signals and generate sounds and actions on the computer. Youth visited the Makey Makey website to access a virtual piano, which plays notes when the electrical circuit is complete. They then tested various materials (pencils, pipe cleaners, feathers, etc.) to see which made the virtual piano play. The facilitator prompted them to consider the conductivity of each item, and guided them to think critically and demonstrate an understanding of the difference in conductivity between materials.

<sup>1</sup> Learn more about Makey Makey here: <https://makeymakey.com/>

# IMPLEMENTATION OF TRANSFORMATIVE PRACTICES

Table One on the following page overviews how these four case studies uniquely demonstrate the different ways in which afterschool programs are implementing MGM's Transformative Practices. Facilitators from each case study program have benefited directly from the various professional development opportunities offered by their Statewide Afterschool Networks from the Million Girls Moonshot initiative.



Table 1: Transformative Practices by Case Study

	<b>LearningWorks, Maine</b>	<b>Link Engineering to Life, Vermont</b>	<b>Oregon Tribal Youth Center, Oregon</b>	<b>North Platte Kids Klub, Nebraska</b>
<b>Engineering mindset</b> activities help girls develop engineering design skills and develop positive attitudes about themselves as problem solvers	Staff created an inclusive environment primed for girls to develop an Engineering Mindset.	Youth work in teams through a series of engineering challenges, including a problem of their own choosing.	The youth center is stocked with state-of-the-art equipment that offer youth hands-on opportunities to use new technologies.	The facilitators promote student-led learning through design and electronic circuitry activities. Rather than telling them what to do and how to do it, students had choice
<b>Inclusive and equitable STEM</b> practices encourage girls to engage in STEM, such as selecting topics of interest to all genders, and working in cooperative groups.	LearningWorks program materials are chosen to ensure that women and girls are not gender-stereotyped.	The LEL program is rich with vetted activities related to equity, access, and representation in STEM.	The program has a sustained focus on culturally responsive curricula. Staff take a youth-centric approach, encouraging youth leadership, voice, and choice.	The program makes connections to the meaning, importance, and utility of STEM, which is correlated with increased motivation—particularly for youth from groups underrepresented in STEM.
<b>Role models, mentors, and families</b> are included in program activities to encourage and support girls in STEM learning.	LearningWorks invites female community leaders in STEM careers to speak with youth. Returning middle school youth serve as mentors to younger children.	The LEL Project Lead, the EJRP Program Coordinator, and UVM mentors all serve as female role models and mentors.	Community members are invited to share their life stories and serve as youth mentors.	The staff make a point of developing trusting relationships with families and serve as both role models and mentors to the youth they serve.
<b>Continuous STEM learning pathways</b> assure that girls who are interested in additional STEM-related activities experience a “warm hand-off” between experiences.	LearningWorks provides local connections to STEM pathways. Staff share websites & other resources with youth who want to deepen their knowledge about a topic.	Resources include videos for each activity by female STEM professionals to connect the youth’s activities to possible college and/or career pathways.	Staff recruit tribal youth from preschool age. Staff also focus on retaining youth as they grow by adapting programming for them and exploring new age-appropriate projects.	Facilitators of afterschool and summer programs are employed as teachers, so they have opportunities to follow up with girls whose interest is sparked during their out-of-school activities.

# PART 2. MEASURING SUCCESS

Program leaders from the case studies were invited to test three instruments to measure program quality and determine the extent to which youth were cultivating an engineering mindset. Instruments were at varying stages of development when each case study was conducted, and incorporating them into the case studies provided valuable insight to improve each instrument to eventually scale across OST programs. Below is a brief description of each instrument. More information about each of these tools can be found within the Million Girls Moonshot Data Toolkit.

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**Dimensions of Success (DoS)**, developed by PEAR, is an observation tool that allows an observer to identify the quality of STEM instruction. It has been designed and tested to provide a common measure of quality STEM instruction in OST programs.

**The Common Instrument Suite for Students (CIS-S)**, developed by PEAR, is a youth survey intended to measure attitudes towards STEM, including such dimensions as self-confidence and STEM identity. Three of the ten characteristics of an engineering mindset are measured by the CIS-S.

**Performance Assessment of Design Skills (PADS)**, developed by STEM Education Insights (SEI), measures a youth's ability to apply the engineering design process, which accounts for the other seven characteristics of an engineering mindset.

This section of the paper describes each instrument, discusses how they were incorporated into the case studies and shares what was learned. The intention was not to compare the programs, but to determine the value of these instruments to provide actionable information to program leaders to support continuous improvement.

## DIMENSIONS OF SUCCESS (DOS)

Developed by Partnerships in Education and Resilience (PEAR), Dimensions of Success (DoS) is an observation tool designed to assess the quality of instruction in afterschool and summer programs. It was the subject of a rigorous research study, which found it to be both a valid representation of good STEM practices in OST programs, and also reliable, in that observers gave very similar ratings to the same class.<sup>2</sup> A two-day training workshop is required to become certified in the use of the DoS instrument.

### Instrument Overview

Depicted in Figure 2, the DoS consists of twelve dimensions organized by the following four domains: Features of the Learning Environment, Activity Engagement, STEM Knowledge and Practices and Youth Development in STEM. Ratings of the quality of instruction are made for each of the twelve dimensions. Observers rate instruction by taking field notes during an observation, then using a rubric to apply rating scores ranging from 1 (evidence of quality absent) to 4 (compelling evidence of quality), with a rating of 3 being the benchmark for quality.

DoS is not intended for leaders to evaluate instructors. Rather, it is intended as a means to identify good qualities of instruction and determine where improvements are needed. DoS observations of each case study were carried out by certified DoS observers, and findings across programs shared valuable insights about the instrument and the programs' progress toward cultivating an engineering mindset in participating youth.

2. Shah, A. M., Wylie, C., Gitomer, D., & Noam, G. G. (2018). Improving STEM program quality in out-of-school-time: tool development and validation. *Science Education*, 102(2). <https://doi.org/10.1002/sce.21327>

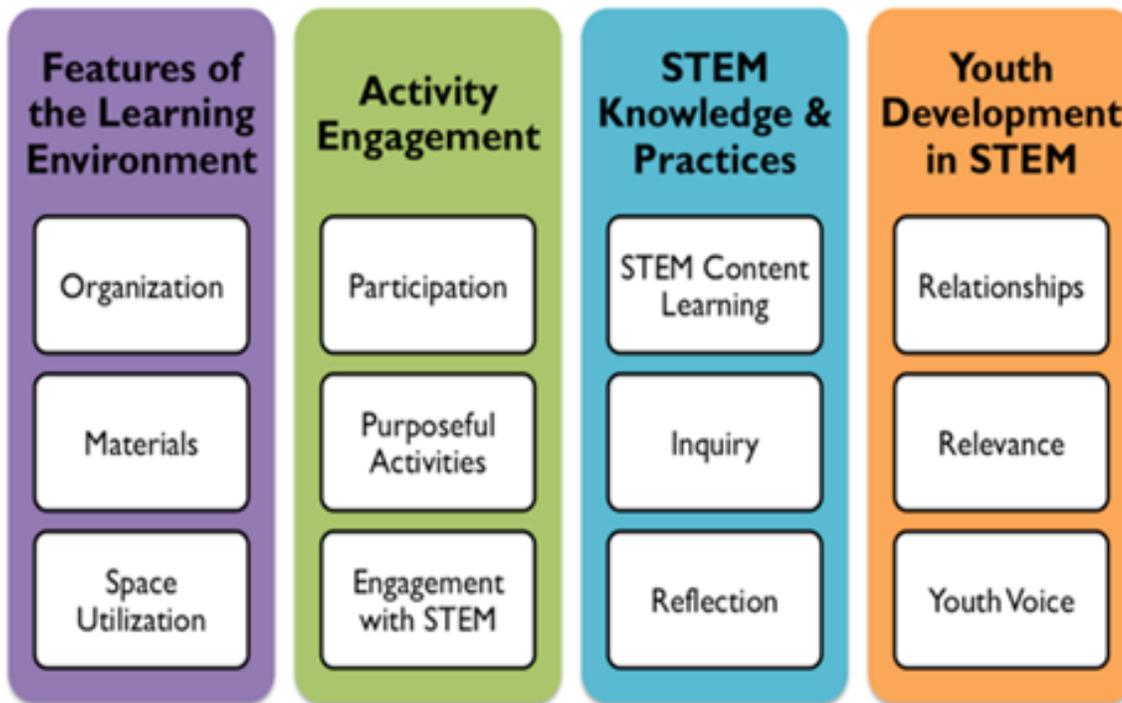


Figure 2: Dimensions of Success Framework

## Evidence of Quality

Researchers across nearly all case studies found five DoS dimensions met the rubric's benchmark for quality instruction: Organization, Materials, Space Utilization, Engagement with STEM and Relationships. The only exception was a slightly lower score for one of the studies in which instruction was carried out via zoom during the height of the COVID-19 pandemic. Following are examples of the use of evidence to support quality ratings:

Engagement with STEM. The DoS observation instrument directs the observer to the nature of the students' learning experience. Are they actually doing science and engineering, or just learning about it? Here is the evidence for authentic engagement in STEM from the North Platte Kids Klub case study:

*Each activity gave youth the opportunity to engage with STEM learning using both their hands and their minds. During Makey Makey, each youth had multiple opportunities to physically touch the circuits, hooking up the leads to different materials to test conductivity. Throughout, they had multiple opportunities to select additional items to test, make predictions about what they expected would occur, and describe what happened. Youth also led the work of solar oven construction, with minimal intervention from adult staff. They had opportunities to engage cognitively and make decisions regarding the oven's design. The facilitators' approach put the learning squarely on the youth, rather than telling them what to do and how to do it, a hallmark of high-quality STEM education in out-of-school time.*

**Relationships.** The DoS observation instrument directs the observer to rate the presence of positive student-facilitator and student-student interactions during the lesson. Observed findings from the Linking Engineering to Life case study revealed strengths in the organization and facilitation of an informal, warm, and positive learning environment, foundational to supporting rich STEM learning.

*At the outset of Part 2 [of the program activity], youth had the option to pick from one of the project ideas suggested in the supporting LEL guide or a project of the groups' own choosing. All youth had to come to consensus on the selected project and contribute to the various phases of imagining, planning, creating and improving...Instead of instructing facilitators and youth to follow instructions exactly as written, [the LEL program empowers] facilitators and mentors... to maintain the role of facilitators—"Strive to be 'the guide on the side, not the sage on the stage'"—to support youth in taking the lead in a creative context.*

## Opportunities for Growth

All case studies reported quality instruction across dimensions in each of the 4 domains suggesting the OST programs are providing valuable learning opportunities for youth. Researchers noted, however, that two DoS dimensions, Reflection and Relevance, consistently fell below the rubric's benchmark for quality instruction. The Reflection dimension of the DoS directs the observer to identify the degree to which students have opportunities to reflect and engage in meaning-making about the activities and related content. The Relevance dimension guides the observer to assess evidence that the facilitator and students are making connections between the STEM content or activities and the students' everyday lives and experiences. These are foundational instructional strategies that trained K-12 educators strive to integrate into their teaching practice. As many OST educators are not credentialed teachers, it is not surprising that these dimensions appeared less frequently across observations. It may be noteworthy for program directors to offer OST STEM educators added support of these dimensions as they can be especially challenging to adopt.

**Engineering Booster.** The DoS instrument was initially developed with science instruction in mind. Given that the goal of the MGM Initiative is to enable girls to develop an engineering mindset, the PEAR team developed a one-page Engineering Booster to allow observers to assess which specific components of the engineering design process were present and the extent to which these were authentic design challenges. As this is a new component of the DoS, it was incorporated into only the LEL case study. Additional research and application of this instrument is underway.

## COMMON INSTRUMENT SUITE FOR STUDENTS (CIS-S: ENGINEERING)

Developed by Partnerships in Education and Resilience (PEAR), the Common Instrument Suite-Student (CIS-S) is a student self-report survey that measures a variety of STEM-related attitudes, including STEM engagement, STEM career knowledge, and STEM identity. Like the DoS, the Common Instrument Suite has been rigorously studied and found to be a valid assessment of students' attitudes towards STEM, whether administered as a pre-post-test or as a post test only.<sup>3,4</sup>

3. Little, T.D., Chang, R., Gorrall, B.K., Waggenspack, L., Fukuda, E., Allen, P.J., and Noam, G.G. (2019). The retrospective pre-test-posttest design redux: On its validity as an alternative to traditional pretest-posttest measurement.

4. Price, L. R. (2018a). Common instrument suite - retrospective sample. In Methodology, measurement, and statistical analysis (MMSA) (pp. 1-44) [Technical report]. San Marcos: Texas State University.

## Instrument Overview

The CIS-S is administered with youth after instruction, to indicate the extent to which participants believe that their attitudes have changed as a result of the program. The survey targets the following three characteristics of engineering mindset which are attitudinal, and therefore appropriate for assessment via survey.

- Youth persist in solving a problem despite challenges and are willing to learn from failure.
- Youth work effectively in teams. They are able to get along well with others, collaborate, and communicate.
- Youth envision themselves as effective engineers.

The characteristics of an engineering mindset are measured by statements organized by seven subscales on the CIS-S: *STEM Engagement*, *STEM Identity*, *STEM Career Knowledge*, *STEM Career Interest*, *Relationships with Peers*, *Critical Thinking* and *Perseverance*. Students respond to each statement using a 5-point Likert scale assessing change in student perception over time. A response of 1 indicates 'much less now', 3 indicates 'about the same', and 5 indicates 'much more now'.

## Instrument Implementation

CIS-S data were collected during two of the four case studies from a total of sixteen youth. Table 2 reports mean (average) responses from one case study sample to showcase how CIS-S data can be presented and interpreted. Similar findings were evident in both samples.

Keeping in mind that youth responses indicated how they have changed as a result of the program, the results indicate, on average, that students' self-reported attitudes became more positive in all of these areas.

**Table 2. Mean responses for each CIS-S subscale**

Scale	Mean Response
<b>STEM Engagement</b>	<b>3.78</b>
<b>STEM Identity</b>	<b>3.63</b>
<b>STEM Career Knowledge</b>	<b>3.47</b>
<b>STEM Career Interest</b>	<b>3.77</b>
<b>Relationships with Peers</b>	<b>3.75</b>
<b>Critical Thinking*</b>	<b>4.00</b>
<b>Perseverance*</b>	<b>4.03</b>

Table 1: Mean Responses for each CIS-S subscale

In sum, the CIS-S is a valuable instrument to measure engineering interest, engagement, and career interest. Understanding youths' engineering attitudes and self-concept as they pertain to recent programming can help leaders effectively shape STEM learning experiences for youth. As more data are collected with the CIS-S, technical assistance from the Million Girls Moonshot team can be meaningfully tailored to cultivate an Engineering Mindset in one million more girls.

## PERFORMANCE ASSESSMENTS OF DESIGN SKILLS (PADS)

Three of the ten characteristics of Engineering Mindset are primarily attitudinal and can be (and are) measured by the CIS-S survey. A survey, however, is not appropriate when it comes to measuring someone's skills, which is why STEM Next Opportunity Fund commissioned the development of the Performance Assessment of Design Skills (PADS). The PADS is a story-based activity for participants to share what they learned about the engineering design process and to determine the extent to which the activities helped youth develop an engineering mindset.

## Instrument Overview

The PADs is designed to measure the following skills:

- Identify constraints and criteria that require tradeoffs.
- Consider problems in context.
- Use of a problem-solving process.
- Investigate the properties and uses of materials.
- Envision multiple solutions.
- Apply science and math knowledge to problem solving.
- Evaluate designs and make improvements.

Through this 45 minute computer-based activity, youth are asked to consider the following design problem:

*Dr. Fox is an animal doctor. She is having trouble getting large animals up onto her table so she can examine them. A design must:*

1. *Get a big animal onto the table without lifting it.*
2. *Work for animals of different sizes and shapes.*
3. *Be safe and comfortable for the animals.*

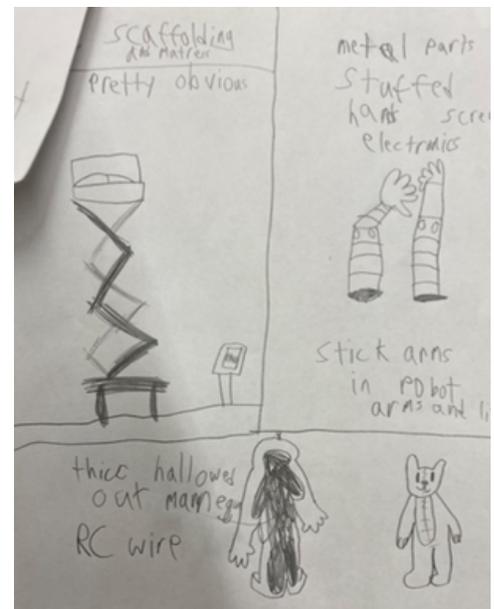
Each item is scored using a rubric, ranging from zero to four with increasing scores indicating greater levels of proficiency in design skills.

## Instrument Implementation

PADs data were collected from two of the case studies from 10 youth. One program was not equipped with computers, so facilitators engaged youth in the problem as an activity, rather than as an assessment (see sketches from youth in Photo 4). Preliminary data from this small sample indicated that:

- While all youth successfully generated ideas to solve an engineering design challenge, different youth showed varying degrees of proficiency in design skills. The youth who expressed a clear interest in the design process were more likely to demonstrate this proficiency through a greater number of ideas that met the criteria/constraints to provide more detailed, and clearer justifications for their designs.
- Youth scored highest on the questions about the materials they would use, and not as high on questions about math and science. Higher scoring youth went into detail about how they would test to make sure their idea to lift the animal would work, while lower scoring youth mentioned simply that they would test it or “use their brains.”

At the time of this writing, the PADs assessment has undergone refinements for a nationwide pilot study that is currently underway. Once available for public dissemination, it is anticipated that the PADs will prove useful as a formative assessment. The PADs design team proposes its most effective use will be as a pre-post assessment that would be built-in to an afterschool engineering series or a summer camp for middle school students. In this form, it will have value as a diagnostic tool for the facilitator to modify their teaching plan accordingly, and as a summative assessment to determine the extent to which the activities helped youth develop an engineering mindset.



Youth Sketch of PADs Activity

# CONCLUSION

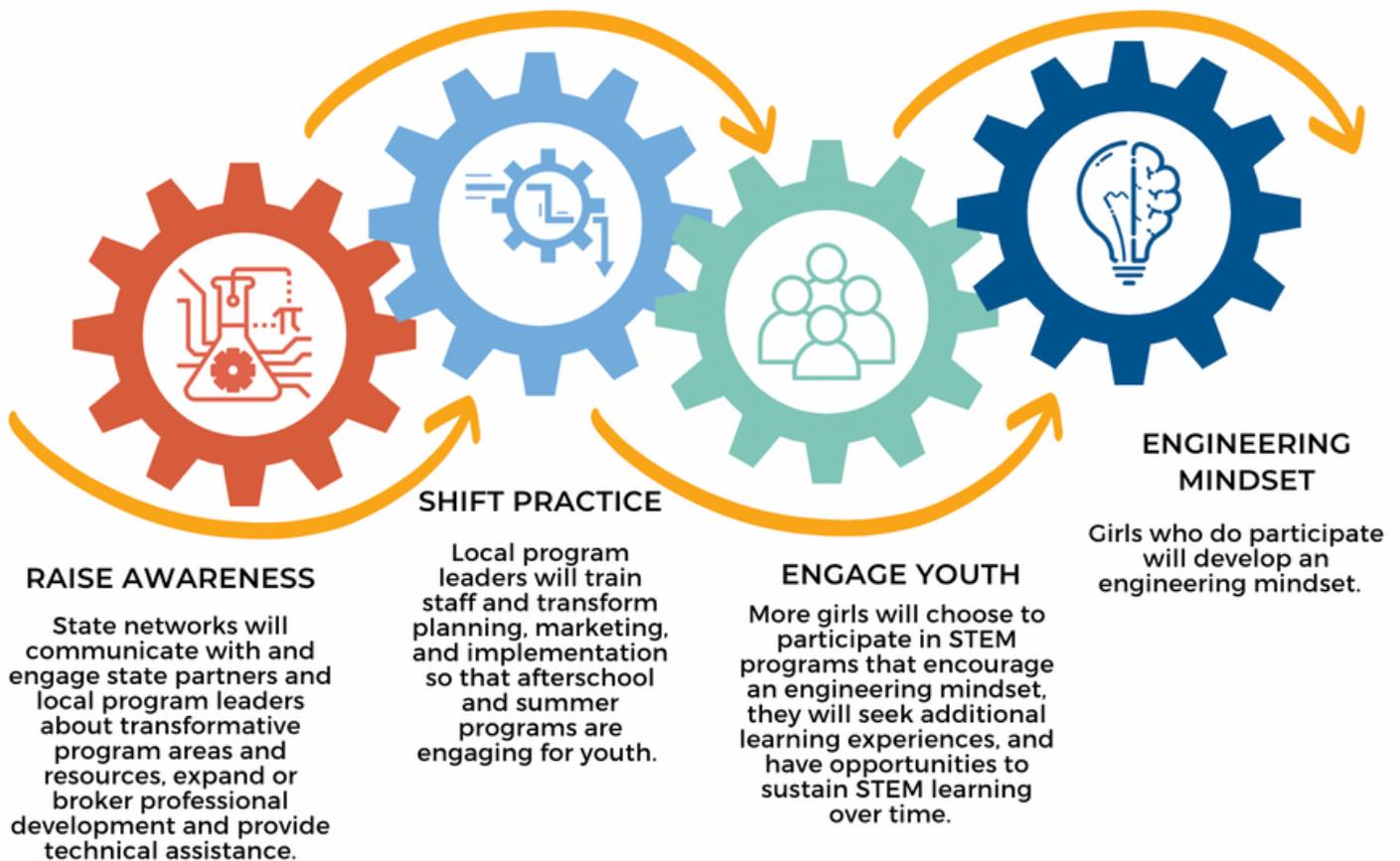
*In light of phases 2, 3, and 4 of MGM's Theory of Action, what have we learned?*

## PHASE 2 SHIFT IN PRACTICE

An in-depth look at how the four programs are implementing transformative practices illustrates a wide variety of approaches. Consider, for example, the practices of being equitable and inclusive. One program admitted only girls and non-binary youth. The other three programs admitted boys and girls, but one carefully chose instructional materials that avoided stereotypes, another emphasized a youth-centric approach with attention to youth voice and choice, and the third emphasized the meaning, importance, and relevance, and utility of STEM learning. These are all clear examples of transformative practices.

## PHASE 3 ENGAGE YOUTH

All the case studies included at least 50% girls or non-binary youth, and all were deeply engaged in the activities their leaders had provided for them. None were simple make-it-and-take-it activities, but rather they engaged the youth in critical thinking and creative problem-solving activities.



## PHASE 4. FOSTER ENGINEERING MINDSET

Though data collected from the CIS-S and PADs were limited in numbers at this early stage of the MGM initiative, early findings suggest youth from case study programs were developing the attitudes about STEM and about themselves that are essential aspects of an engineering mindset. Youth are learning to be persistent in problem-solving despite setbacks; they are engaging enthusiastically in teamwork, and many are developing a self-image as a person who can be an engineer.

# NEXT STEPS

Given that these case studies were conducted during the first year of the MGM Initiative, during a pandemic, we are pleased with how much movement we've seen towards the development of Transformative Practices, leading to the engagement of more girls and non-binary youth, and indications that they are at least beginning to develop an engineering mindset. If the current effort to develop a valid and reliable performance assessment is successful, we will be well on our way to having the tools that we will need to fully test the Theory of Action.

As discussed in Part 2 of this synthesis, a study is currently underway with three summer and fall programs across the United States to validate the PADS assessment for its value in measuring seven of the engineering mindset characteristics. Findings from this study are anticipated to be released early in 2023.

As we embark on Year 3 of the MGM initiative, many Afterschool Networks have committed to collecting a meaningful sample of program and youth level data. Steps are underway to support Networks as they utilize the discussed PEAR tools (DoS & CIS-S), as well as the educator's version of the Common Instrument Suite (CIS-E) and the other data collection instruments required for the MGM Annual Report. Conducting future case studies is also anticipated to further understand the impact of the Million Girls Moonshot.



# ACKNOWLEDGEMENTS

We are grateful to the facilitators and leaders of the organizations that opened their programs to us and shared their achievements and challenges so that others doing similar work can continue to improve their programs.

## AUTHORS OF CASE STUDIES

**Linking Engineering to Life, Village of Essex Junction, Vermont**  
Partnerships in Education and Resiliency (PEAR)

Hannah B. Meisels  
Kristin M. Lewis-Warner  
Gil G. Noam  
Dr. Habil

**LearningWorks, Waterboro, Maine**  
Afterschool Coaching for Reflective Educators in STEM (ACRES)

Kate Kasterlein  
Sue Allen

**Oregon Tribal Youth Center, Myrtle Creek, Oregon**

Public Profit  
Corey Newhouse

**North Platte Kids Klub, North Platte, Nebraska**

Public Profit  
Corey Newhouse

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## STEM NEXT OPPORTUNITY FUND

**Executive Director:** Ron Ottinger  
**Director of Million Girls Moonshot Initiative:** Teresa Drew  
**Staff and Consultants:** Victoria Wegener, Sabrina Gomez,  
Cary Sneider, Andria Parrott