

# A Guide to PEAR's STEM Tools: Dimensions of Success & Common Instrument Suite



## The PEAR Institute: Partnerships in Education and Resilience

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To obtain permission(s) to use material from this work, such as this Instruction Manual or the Common Instrument survey, please submit an email request to PEAR's STEM Training, Coaching & Network Manager, Tracy Callahan, at [tcallahan@mclean.harvard.edu](mailto:tcallahan@mclean.harvard.edu)

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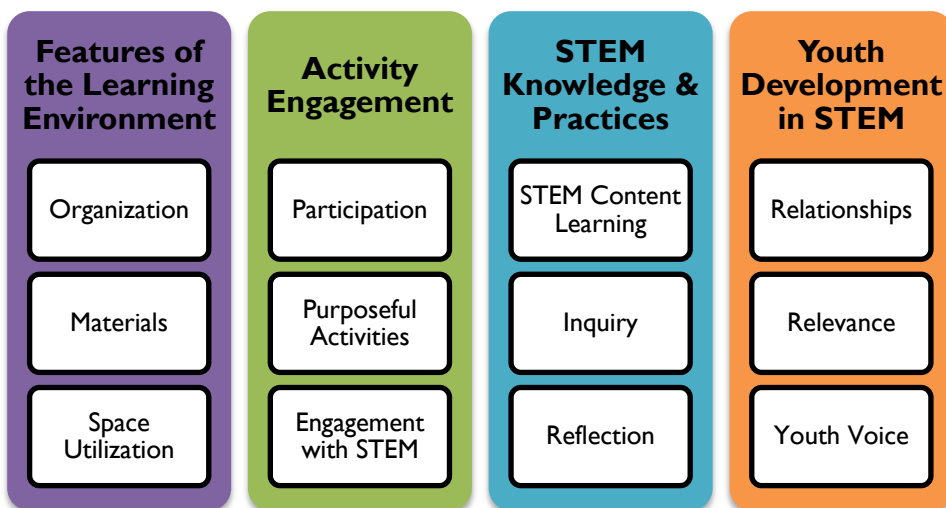
# Introduction

The PEAR Institute: Partnerships in Education and Resilience creates and fosters evidence-based innovations in socio-emotional learning (SEL) and Science, Technology, Engineering and Math (STEM) so that increasingly “young people can learn, dream, and thrive.” PEAR is located at McLean Hospital in Belmont, MA and is affiliated with Harvard Medical School. Over the last 15 years, The PEAR Institute has evolved into a recognized translational center that adapts research findings into practices for schools and afterschool programs. PEAR is delighted to work with you to help ensure that children have positive, high-quality experiences when they participate in OST STEM activities.

PEAR has developed two widely used tools to quantify STEM outcomes: a self-report survey for students called the Common Instrument Suite (CIS) and a program quality observation tool called Dimensions of Success (DoS). Together, these tools form the PEAR STEM Toolkit. This document provides an overview of these tools and the next steps for how to use the tools to improve your students’ OST STEM experience!

## Dimensions of Success (DoS)

Dimensions of Success (DoS), is an observation tool that measures the quality of students’ STEM learning experiences in informal/out-of-school time (OST) settings. PEAR developed and studied the DoS tool with funding from the National Science Foundation, along with partners at Educational Testing Service (ETS) and Project Liftoff for the past six years. The DoS tool defines twelve evidence-based indicators, or dimensions, of quality. Certified observers rate each dimension on a 4-point rubric. Currently, some observers are piloting its use to examine STEM experiences during the school day as well.



The twelve DoS dimensions fall in four broad domains: Features of the Learning Environment, Activity Engagement, STEM Knowledge and Practices, and Youth Development in STEM.

The first three dimensions look at features of the learning environment that make it suitable for STEM programming (e.g., do kids have room to explore and move freely, are the

materials exciting and appropriate for the topic, is time used wisely and is everything prepared ahead of time?).

The second three dimensions look at how the activity engages students: for example, they measure whether or not all students are getting opportunities to participate, whether they are doing activities that are engaging them with STEM concepts or something unrelated, and whether or not the activities are hands-on, and designed to support students to think for themselves versus being given the answer.

The next domain looks at how the informal STEM activities are helping students understand STEM concepts, make connections, and participate in the inquiry practices that STEM professionals use (e.g., collecting data, using scientific models, building explanations, etc.).

Finally, the last domain assesses the student-facilitator and student-student interactions and how they encourage or discourage participation in STEM activities, and whether or not the activities make STEM relevant and meaningful to students' everyday lives, and the experiences. Together, these twelve dimensions capture key components of a STEM activity in an informal afterschool or summer program.

## Factors to Consider for Quality Observations

DoS can be used in two important ways. It can be used as a self-assessment observation tool for STEM program administrators and staff so they can understand the strengths and weaknesses in their programming. DoS can also be used by external evaluators or funders to track quality in programs over time and/or quality across a city or a state.



Programs can choose to be observed by either internal staff or external evaluators who are trained and certified to use the tool. While all staff at a site may not have time to become fully certified DoS observers, they can still learn to *plan* for high quality using the DoS dimensions. See our DoS Program Planning Tool here: <http://pearweb.org/tools/dostool.html>

If you are planning to use DoS, there are several items to consider:

### ***What are your goals for assessment/evaluation?***

- Do you want to help your program or the programs in your state/organization/region pinpoint their strengths and weaknesses?
- Do you want to compare and contrast quality across programming at different sites of an organization (e.g., Boys and Girls Clubs or YMCAs)?
- Do you want external evaluators to use DoS to report quality across the state?
- Do you want to collect internal scores about the quality of your STEM activities so you can reflect and improve with your staff?
- Do you want to understand the strengths and gaps across an entire state network or region and analyze patterns for system-level decision making (Mott Networks)?

### ***Who will be using DoS and how often?***

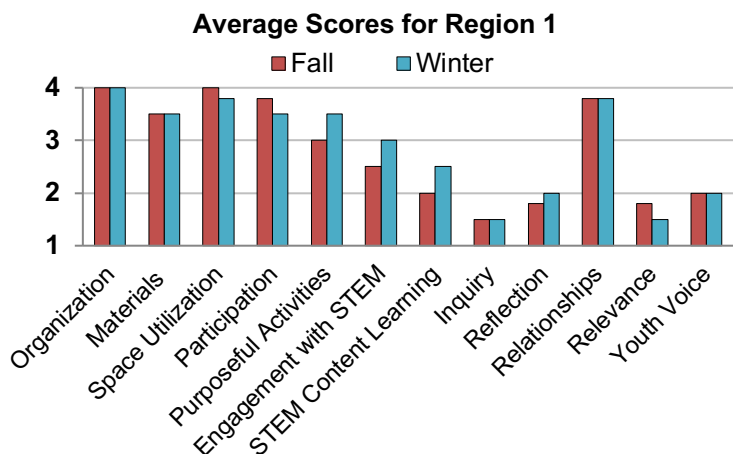
- Do you want staff at each site to observe each other's lessons? How often will they observe?
- Do you want program leaders to observe each site twice?

- Do you want state representatives from the STEM board to visit each site in Fall and Winter?

### ***What will you do with the data?***

- Will ratings be discussed internally with staff?
- Will you be reporting ratings to funders?
- Will you request and discuss quarterly reports (created by PEAR)?
- What type of comparisons/analyses do you hope to conduct (i.e. Module Reports, Regional Reports, or State wide Reports)?
- Do you want to connect observation data (DoS) with outcome data? Do you want to compare curricular units, particular age groups, or facilitators? DoS can be used in customized ways, so think about the story you want to tell with the data, and PEAR will consult with you to come up with the best plan for your individual needs.

## DoS Reports



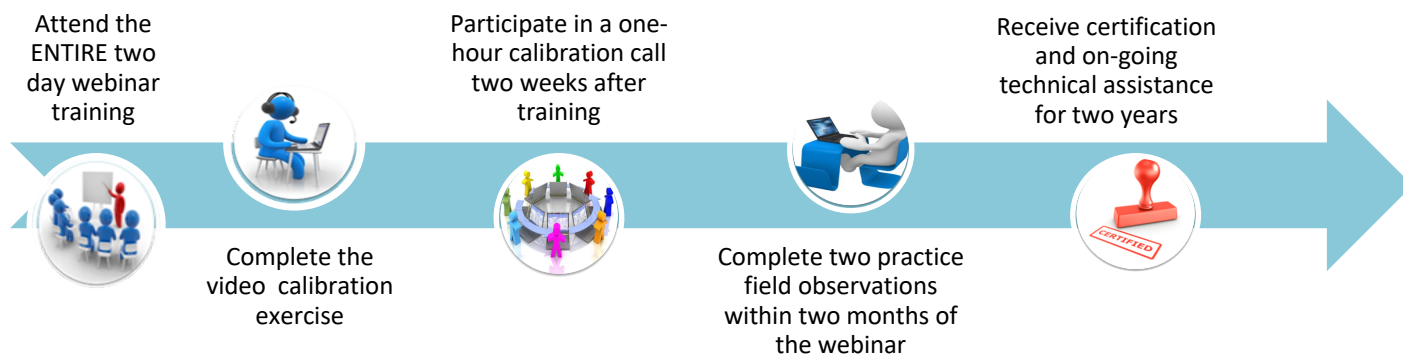
PEAR will provide quarterly reports upon request. PEAR will work individually with clients to decide how to analyze the DoS data in a way that is most meaningful to the Program. Our most common reports break down DoS data by time, location, and/or module. Note that if you administer the corresponding student survey (Common Instrument Suite), DoS results will be incorporated into the Excel data dashboard that is used to report student-level findings.

## Next Steps to Use DoS: Certification

To use DoS, a potential observer must complete the entire certification process – a total of four steps.

1. **Trainees must attend a 2-day training** (in-person or online) to learn how to define and observe quality in each dimension.
2. **Trainees will complete a set of video simulation exercises** to practice their understanding of the tool. PEAR will review each trainee's ratings and evidence and provide individual feedback.
3. **At a one-hour calibration session (phone conference)**, PEAR trainers will address any questions from the video exercises and will provide additional examples to help clarify the use of the tool.
4. **Trainees will then arrange to practice using DoS in the field** at afterschool sites in their local area. This step allows trainees to use the tool in the field and to incorporate any feedback they received on the video simulations to their observations. Trainers can also catch any possible struggles a trainee may be having with the tool. This will allow the trainers to work with trainees to fix these issues before certification.

Upon successful completion of all these requirements, observers will be DoS certified for 2 years and can use the tool as often as they would like during that period. After 2 years, re-certification is needed to continue to observe and collect data with DoS.



For more information about The DoS Observation tool and certification, please contact Tracy Callahan, STEM Training, Coaching & Network Manager at 617-484-3645 x236 or [tcallahan@mclean.harvard.edu](mailto:tcallahan@mclean.harvard.edu)

## Common Instrument Suite (CIS)

The Common Instrument Suite (CIS) is a youth self-report survey that measures a variety of STEM-related attitudes, including STEM engagement, STEM career knowledge, and STEM identity. It was initially developed with informal/outside-of-school time (OST) STEM programs in mind, but the survey can also be completed by students in school because the concepts are equally applicable. The purpose of the survey is to better understand how informal STEM programming impacts students' perceptions/attitudes towards STEM.

Thanks to funding from the Noyce Foundation (now STEM Next at the University of San Diego), the original Common Instrument (CI) was developed in 2009 by Dr. Gil Noam (director of PEAR) and OST practitioners and educators from major organizations like Girls Inc. and 4-H. It has been administered over 60,000 times to students enrolled in informal/OST STEM programs across 47 U.S. states as well as eight countries in Asia, South America, and Europe. Importantly, the CI has demonstrated strong psychometric properties (in previous work using advanced methods to assess validity and reliability).

PEAR is now working to expand the original CI survey to include other important indicators inspired by the internationally recognized Programme for International Student Assessment (PISA; OECD.org) and Holistic Student Assessment (HSA) surveys (Noam et al., 2012)..

- The PISA-related items measure how knowledgeable and interested students are in obtaining STEM careers, how intrinsically motivated students are to be involved in STEM-related activities, and how much students enjoy performing and learning about STEM.
- The HSA assesses 21<sup>st</sup>-century skills that are highly correlated with interest and achievement in STEM, particularly perseverance, critical thinking, and relationships with peers and adults.

The CI/CIS typically takes between 5 and 20 minutes to complete depending on the number of outcome measures included on the survey, the type of survey design used, and the age of students. The following table shows all of the possible outcome measures that can be included on the CIS survey, but the PEAR



Institute will work with you to customize a survey that will meet your evaluation goals. We also take into account the age of your students and the duration of your STEM programming.

Outcome Measures for the CIS		
<b>STEM-Related Attitudes</b>	<i>STEM Engagement</i>	Interest and excitement in participating in STEM and STEM activities
	<i>STEM Identity</i>	Understanding of oneself as a “STEM person”
	<i>STEM Career Interest</i>	Motivation to pursue a career in STEM
	<i>STEM Career Knowledge</i>	Knowledge of STEM-related careers and the steps to attain them
	<i>STEM Activity Participation</i>	Pursuit of STEM activities in one’s everyday life
<b>21<sup>st</sup>-Century Skills / Socio-Emotional Learning (SEL)</b>	<i>Relationships with Adults</i>	Positive connections and attitudes toward interactions with adults
	<i>Relationships with Peers</i>	Positive and supportive social connections with friends and classmates
	<i>Perseverance</i>	Persistence in work and problem-solving despite obstacles
	<i>Critical Thinking</i>	Examination of information, exploration of ideas, and independent thought

In addition, we offer three types of survey designs: (1) traditional pretest-posttest, (2) retrospective change, and (3) retrospective pretest-posttest. The survey items are the same across these designs, but the framing of questions differ to allow for students to think about the items from different points of view.

1. The **traditional pretest-posttest** method is the most widely-used design, and students are asked to complete the survey twice: once at the beginning of the program and once at the end of the program. Change is measured by subtracting pretest scores from posttest scores. This survey is typically on a 4-pt Likert scale from, for example, “Strongly Disagree” to “Strongly Agree.”
2. The **retrospective pretest-posttest** method is similar to a traditional pretest-posttest, but students answer each question twice (in one sitting) from two different frames of reference: “before the program” and “at this time,” respectively. The survey is only administered once at the end of the program (but can be paired with a pre/baseline survey), and students reflect essentially on the level of change they experienced “then” compared to “now.” This survey is on the same 4-pt Likert scale as the traditional pretest-posttest. The response scales are presented on the left and right sides of the page (i.e., “Before Program” and “Today”) with the survey items in the middle.
3. The **retrospective self-change** method also asks students to reflect on how much they feel they have changed, except that the survey is only administered once at the end of the program (though can be paired with a pre/baseline survey) and students only need to answer each question once. Specifically, students are shown a sentence and are asked to think back to the beginning of the program and rate whether they do/feel things less or more because of the program. This survey is typically on a 5-pt Likert scale from “Much Less Now – About the Same – Much More Now.”

## Factors to Consider

To be sure the CIS survey is appropriately customized for your program, there are a number of factors for you to consider:

### **What is the age/grade of your students?**

- The CIS is recommended for Grades 4 and above. For programs with younger students (K-3), we strongly recommend a read-aloud protocol (either one-on-one or in small groups) and use of the CI (STEM Engagement) scale only.



### **Will you need the survey to be translated into another language?**

- The CIS is available in English and Spanish. Other translations may be available upon request.

### **Does your program have a specific STEM focus?**

- The CIS uses the word “STEM” or “science” generally, however, we can customize the survey for programs with specific STEM focuses. For instance, if you are a math program, we would substitute the word “science” for “math” where possible/appropriate.

### **How will you administer the survey?**

- The survey is available in PDF to print, or we can create survey links to access the survey online using an electronic device with reliable internet access. We encourage programs to administer the survey electronically when possible – it helps you avoid a lot of data entry and shortens the data processing/reporting time!

### **How often do you administer the survey?**

- The traditional pretest-posttest design requires two administrations, whereas the retrospective change and retrospective pretest-posttest designs require only one administration. If staff time or teaching time is limited, you may prefer to use one of the two retrospective options. The retrospective designs are also strongly recommended for programs that offer STEM activities for three weeks or less.

### **Which survey design do you want to use?**

- There are pros and cons for every survey design. The traditional pretest-posttest design has the advantage of being the most widely used design, and it allows you to establish a baseline of how students are feeling about STEM before they experience your program. On the other hand, the pretest-posttest design requires more time and is prone to a phenomenon called “response-shift bias.” This typically occurs after students have participated in the program and the students’ perception of themselves (or their understanding of concepts) has changed due to their learning experiences in the program. Research has shown that students often overestimate their beliefs, feelings, or ability on the pretest at the start of programs, which frequently results in neutral or negative outcomes when subtracting pretest and posttest scores – even if the students felt they learned a lot! The retrospective designs avoid this response-shift bias, however the concept of reflecting back and thinking about change can be cognitively challenging for younger students. Thus we recommend the retrospective designs for older students (Grades 4 and above).

### **How much will it cost to use the survey or consult with The PEAR Institute?**



- Please contact The PEAR Institute for more information. The cost for using the CIS is dependent on a variety of aspects, such as the number of surveys to be administered and survey design.

### What else does PEAR use our data for?

- PEAR de-identifies all data and adds it to a growing database. This allows us to establish national norms and to inform on national trends in STEM education.

## Next Steps to Use CIS

Once you have decided upon the factors mentioned above, you should contact the Research Department at The PEAR Institute and set up a phone conversation (see contact information below).

### Roles of the program:

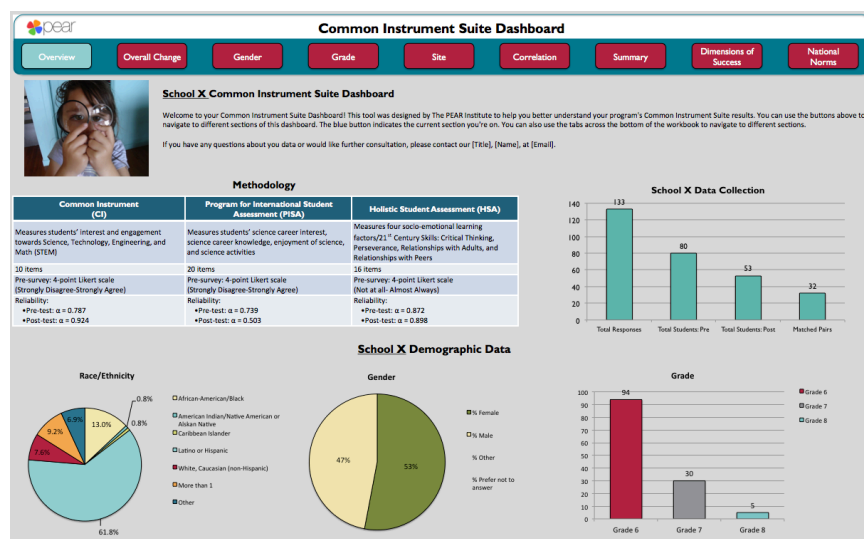
- Your program will work with PEAR to devise a survey that will best meet your goal(s).
- Your program staff will take the lead in managing survey administration and data collection.
- Your program will determine whether parental consent (passive or active) is required.
- Your program staff will assign student IDs (when necessary, such as pretest-posttest designs).
- Your program staff will enter paper/pencil surveys unless if you administer them electronically.
- Your program staff will notify PEAR when data collection is complete.

### Roles of The PEAR Institute:

- Our team will work with you to decide on the right survey items, format, and design.
- Our team will create PDF files and/or survey links so that you can easily administer the survey.
- Our team will process your program's de-identified data and perform statistical analyses.
- Our team will return to you a report with your program's unique results within 7 business days.

## CI/ CIS Reports

PEAR will compare your program's data to our national database so you can understand how your students compare to students across the U.S. The data report you will receive is an Excel Dashboard that visualizes demographics and results overall, by gender, by grade, and by site.



For more information about using the PEAR Common Instrument Suite, please contact Tracy Callahan, STEM Training, Coaching & Network Manager at 617-484-3645 x236 or [tcallahan@mclean.harvard.edu](mailto:tcallahan@mclean.harvard.edu)

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