A Guide to PEAR's STEM Tools: Common Instrument Suite (Student and Educator) &

Partnerships in Education and Resilience

Table of Contents

Introduction

Partnerships in Education and Resilience (PEAR) creates and fosters evidence-based innovations in social-emotional learning (SEL) and Science, Technology, Engineering and Math (STEM) so that increasingly "young people can learn, dream, and thrive." PEAR was founded in 1999 by Dr. Gil Noam while he was a professor at Harvard Graduate School of Education (HGSE) and Harvard Medical School's psychiatric teaching hospital, McLean Hospital where it was called the Program in Afterschool, Education, and Research (PAER). In 2007, PEAR moved from its primary location at HGSE to McLean Hospital and became PEAR. In the fall of 2020, PEAR spun off from McLean Hospital and became a Benefit Corporation. Over the last 20 years, PEAR 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 and school-based STEM activities.

PEAR has developed three widely used tools to quantify STEM outcomes: a self-report survey for students called the Common Instrument Suite-Student (CIS-S), a self-report survey for educators called the Common Instrument Suite-Educator (CIS-E), 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' STEM experiences!

Common Instrument Suite Student (CIS-S)

The Common Instrument Suite-Student (CIS-S) 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 130,000 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 survey has demonstrated strong psychometric properties (in previous work using advanced methods to assess validity and reliability).

PEAR has worked to expand the original Common Instrument (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), which are now included in the Common Instrument Suite-Student (CIS-S).

- 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 21st-century skills that are highly correlated with interest and achievement in STEM, particularly perseverance, critical thinking, and relationships with peers and adults.

The CIS-S 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-S survey. We also take into account the age of your students and the duration of your STEM programming.

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

In addition, we offer three types of survey designs: (1) traditional pretest-posttest, (2) retrospective pretest-posttest, and (3) retrospective self-change. 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-S survey is appropriate for your program, there are a number of factors for you to consider:

What is the age/grade of your students?

- The CIS-S 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) only.

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

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

How will you administer the survey?

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

How often do you administer the survey?

- Frequency of administration varies based on survey design: the traditional pretest-posttest 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 strongly recommended for programs that offer STEM activities for three weeks or less.
- If surveying youth at multiple time points aligns with your program and desired number of reporting periods, an administration schedule linked with programming and reporting can be discussed with PEAR.

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 PEAR?

- Please contact PEAR for more information (contact@pearinc.org). The cost for using the CIS-S 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-S

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

Roles of the program:

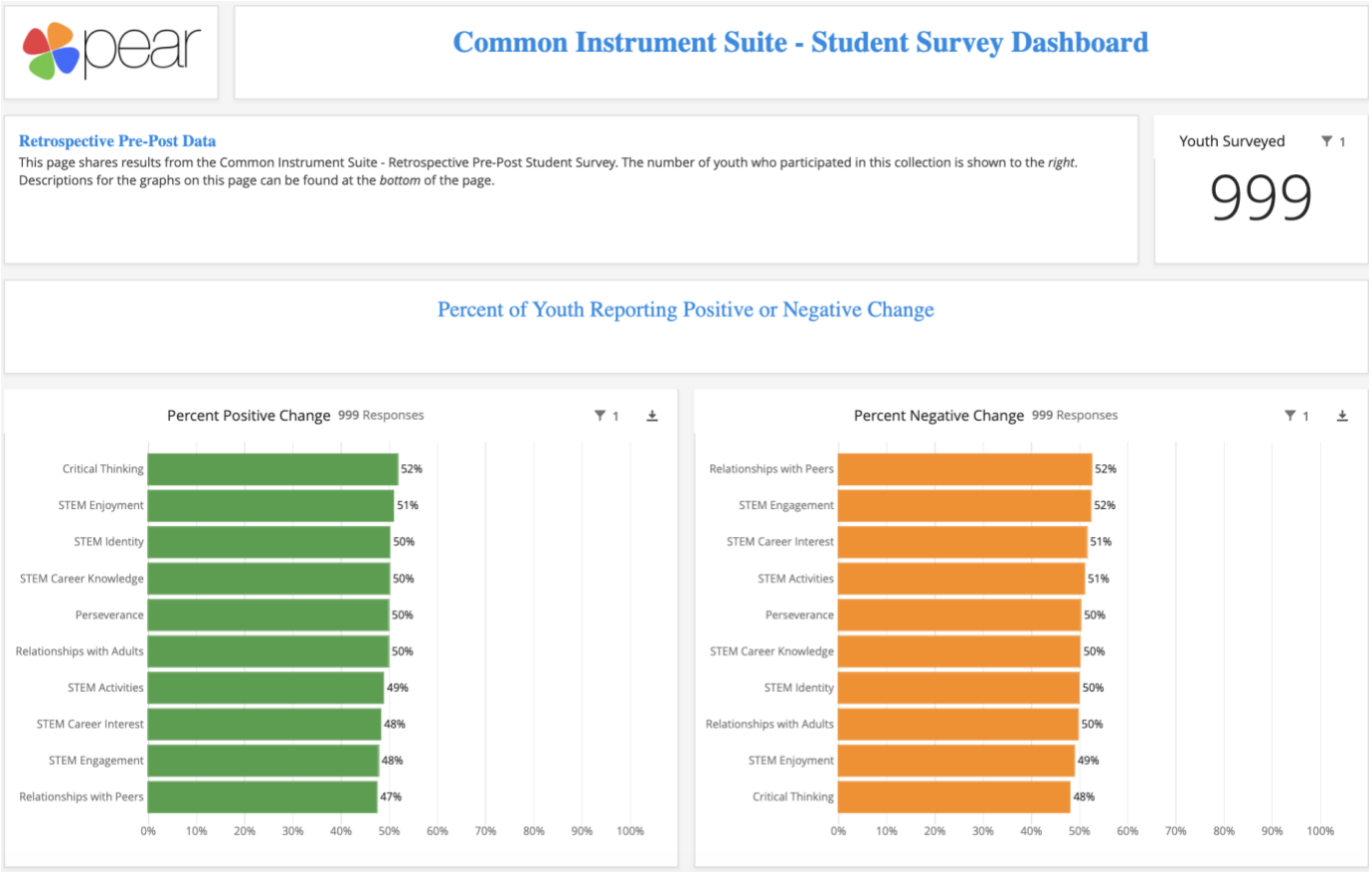
- Your program will work with PEAR to select a survey that will best meet your goal(s).
- Your program staff will take the lead in managing survey administration and data collection.
- Your program will determine whether parental consent (passive or active) is required.
- Your program staff will assign 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 PEAR:

- 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 14 business days.

CIS-S 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 a Qualtrics Dashboard that visualizes demographics and results overall, using filters including gender, age, and race/ethnicity.



Common Instrument Suite Educator (CIS-E)

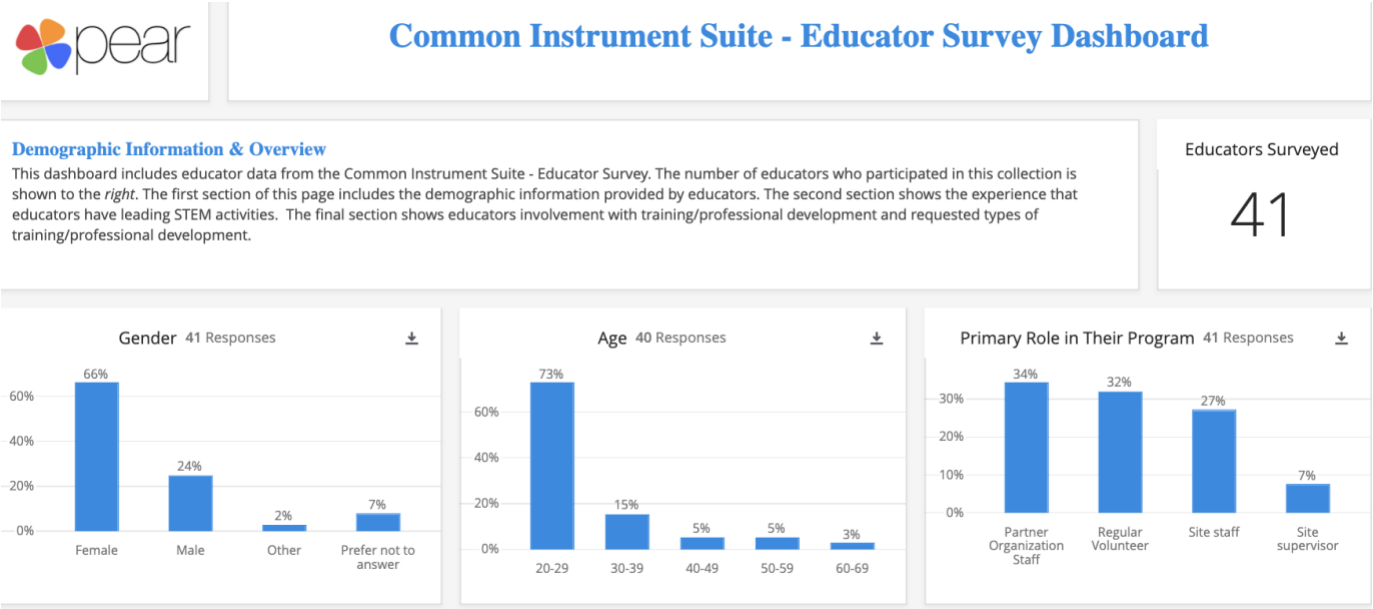
The Common Instrument Suite Educator Survey (CIS-E) is a retrospective self-report survey designed to capture the unique qualities of STEM programs and the practitioners who lead them. Developed to complement both the Common Instrument Suite Student Survey (CIS-S) and the Dimensions of Success (DoS), the CIS-E enables programs to capture key information about who is leading STEM activities, educators' levels of support and perceived efficacy in delivering STEM content, and perceived ease of incorporating DoS-aligned practices. The survey was designed for any in- and out-of-school time staff leading or co-leading STEM activities and can be implemented as a standalone tool or alongside the CIS-S and/or DoS to create a holistic picture of the quality and impact of your programming.

The following table provides examples of data that can be gathered using the CIS-E:

Example Questions that the CIS-E Can Answer	
Educator and Program Background	Who is leading STEM in our afterschool program? Do our educators come from similar backgrounds as the students we serve (e.g., gender, race/ethnicity)? What are the top three areas of support desired by educators in our program?
Educator Attitudes Toward STEM	Do educators feel their own levels of confidence, ability, or interest in facilitating STEM have changed? How easy/challenging is it for educators to incorporate DoS-aligned practices?
Educator Perceptions of Youth Outcomes	Do educators feel they have improved student outcomes in various STEM and SEL areas? If so, how much do they feel youth have changed?

CIS-E Reports

PEAR is able to present your program's data in our dynamic, online data platform. Educator data can be presented in its own dashboard or alongside pages containing CIS-S and/or DoS data!



Factors to Consider

How often do you administer the survey?

- The CIS-E survey is retrospective and should be administered once at the end of programming. It takes approximately 15 minutes to complete.
- If surveying educators at multiple time points aligns with your program and desired number of reporting periods, an administration schedule linked with programming and reporting can be discussed with PEAR.

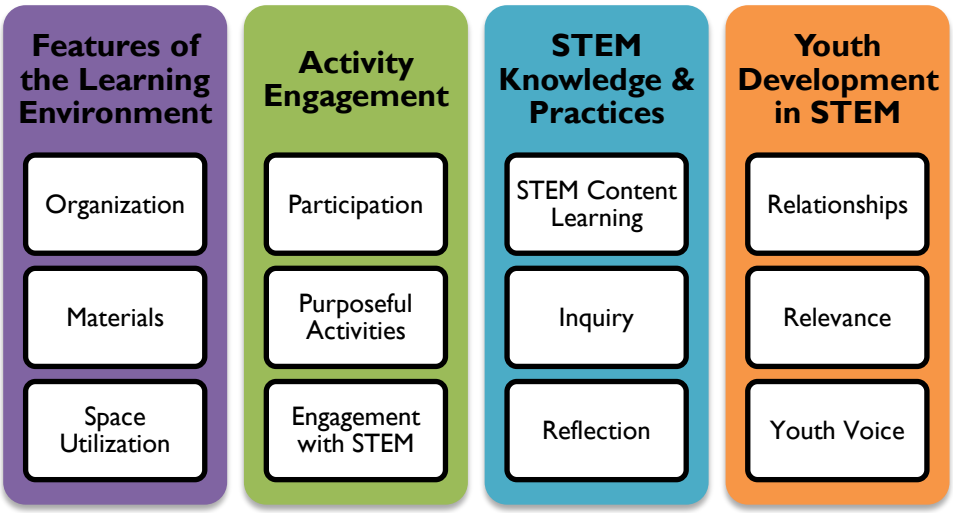
How will you administer the survey?

- PEAR can create survey links to access the survey online. The survey can be accessible both on a computer as well as a mobile device with reliable internet acces

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 and has also been used successfully in school 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. The DoS tool defines twelve evidence-based indicators, or dimensions, of quality. Certified observers rate each dimension on a 4-point rubric.

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 is 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: https://www.pearinc.org/dos-planning-tool.

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?

Who will be using DoS and how often?

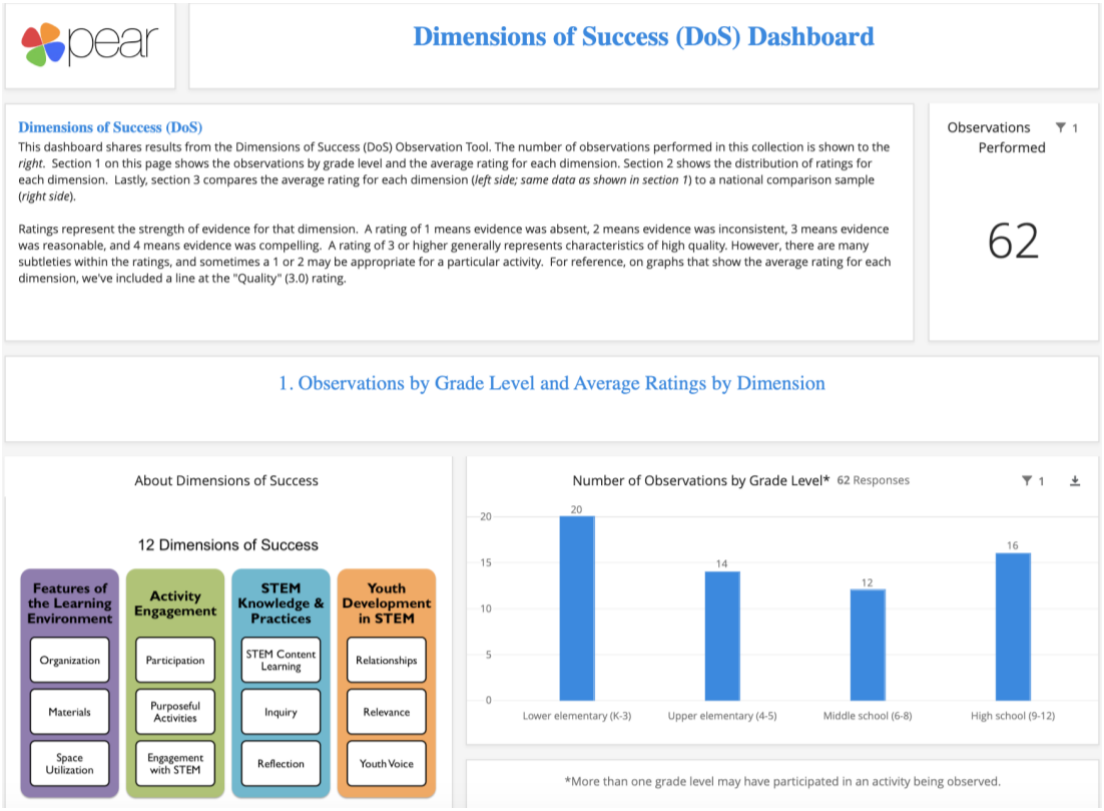
- Do you want staff at each site to observe each other's lessons? How often will they observe?
- Do you want program leaders to observe each site twice?
- Do you want state representatives from the STEM board to visit each site in Fall and Winter?

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 reports (created by PEAR)?
- What type of comparisons/analyses do you hope to conduct (i.e. Module Reports, Regional Reports, or Statewide Reports)?
- Do you want to connect observation data (DoS) with outcome data? Do you want to compare curricular units, particular age groups, or facilitators? 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 reports up to three times per year per program upon request. Our most common reports break down DoS data by time, location, and/or module. Note that you can also receive your DoS data in a standalone Qualtrics dashboard. If you administer the corresponding student survey and/or educator survey, DoS results will be incorporated into the Qualtrics data dashboard that is used to report survey findings.



Next Steps to Use DoS: Certification

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

1. **Trainees must complete the required pre-training work**: an online pre-training quiz and technology check.
2. **Trainees must attend a 2-day training** (in-person or online) to learn how to define and observe quality in each dimension.
3. **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.
4. **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.
5. **Trainees will then arrange to practice using DoS in the field**. 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.

Assessment Tools in Informal Science (ATIS)

PEAR's Assessment Tools in Informal STEM (ATIS) an in-depth compilation of high-quality informal science, technology, engineering, and math (STEM) assessments for children, youth, and adults. Originally funded by the Noyce Foundation, this site seeks to increase the use of psychometrically-evaluated tools in STEM programs, so that facilitators and educators can use valid and/or reliable tools more often and compare results across evaluators or programs. ATIS has been the go-to resource for informal STEM tools for 10 years. Users can search for tools by factors like age, assessment type, and STEM domain and read and write reviews of the tools.

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For more information, contact us at: https://www.pearinc.org/contact or email contact@pearinc.org