The NASA Office of STEM Engagement (OSTEM) and NASA Mission Directorates offer a broad and diverse portfolio of student experiences, challenges, and competitions. The goal of these activities is to spark and sustain interest of K-12 students in STEM by connecting them and their formal and informal educators to authentic STEM experiences and NASA's endeavors in exploration and discovery.

PURPOSE

The purpose this study was to collect and analyze student outcome data and Activity Manager feedback to inform efforts to better understand the impact of NASA's K-12 STEM Engagement investments and facilitate utilization of findings.

METHODOLOGY

The study used a mixed-methods design, combining qualitative and quantitative data to answer three evaluation questions (Figure 1).

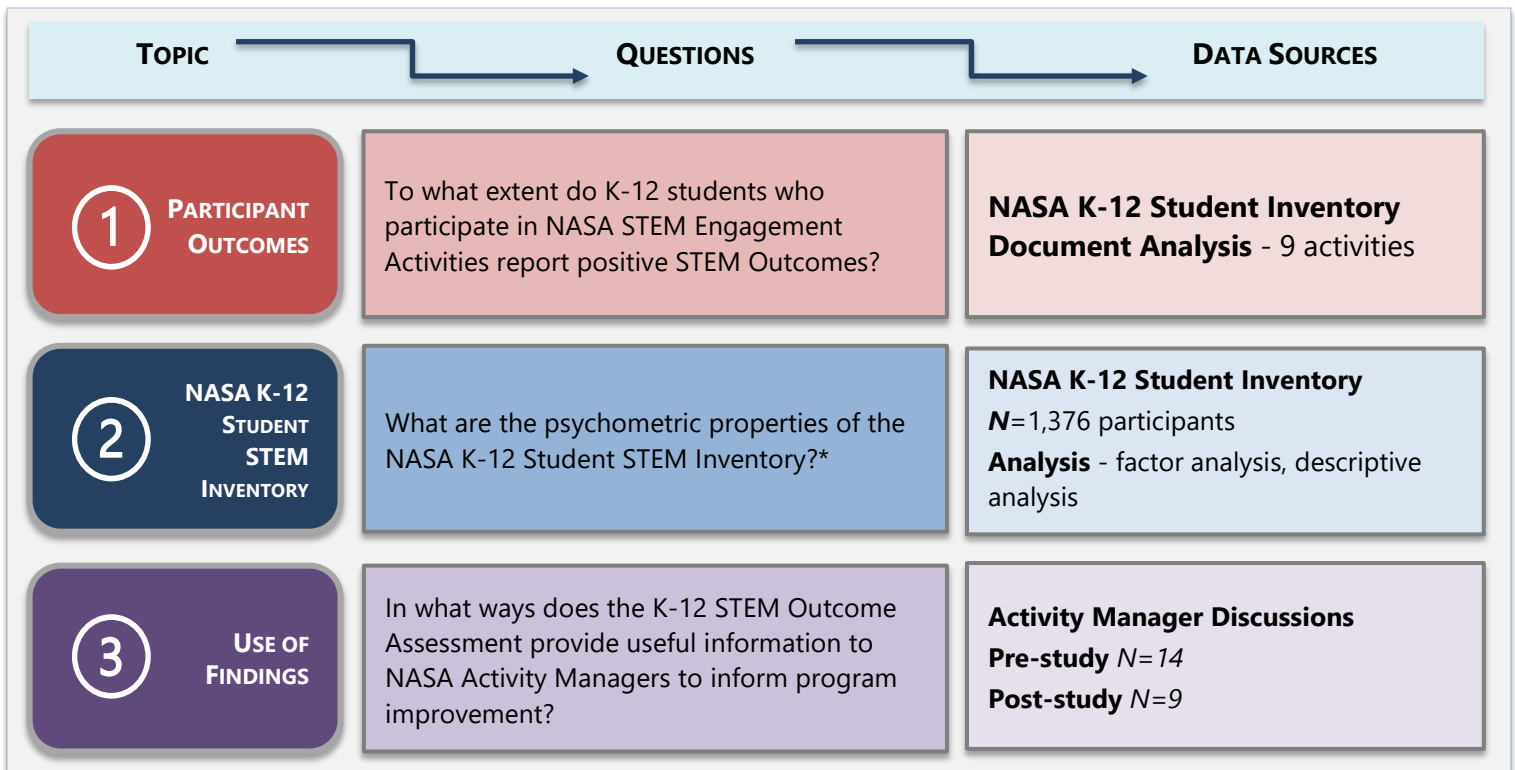| TOPIC	QUESTIONS	DATA SOURCES
1 PARTICIPANT OUTCOMES	To what extent do K-12 students who participate in NASA STEM Engagement Activities report positive STEM Outcomes?	**NASA K-12 Student Inventory Document Analysis** - 9 activities
2 NASA K-12 STUDENT STEM INVENTORY	What are the psychometric properties of the NASA K-12 Student STEM Inventory?*	**NASA K-12 Student Inventory** N=1,376 participants **Analysis** - factor analysis, descriptive analysis
3 USE OF FINDINGS	In what ways does the K-12 STEM Outcome Assessment provide useful information to NASA Activity Managers to inform program improvement?	**Activity Manager Discussions** **Pre-study** $N=14$ **Post-study** $N=9$

Figure 1. Evaluation Questions and Associated Data Sources

ACTIVITY DOCUMENT ANALYSIS. Activity Managers provided documents that described the activity and its goals (e.g., program description, number of student contact hours, goals and objectives, target population, and number of participants).
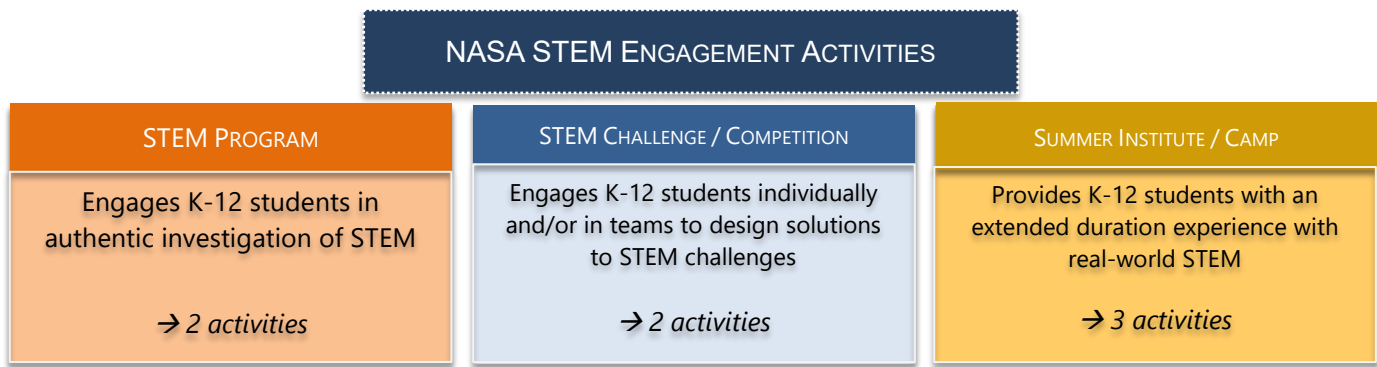
NASA STEM ENGAGEMENT ACTIVITIES

STEM PROGRAM	STEM CHALLENGE / COMPETITION	SUMMER INSTITUTE / CAMP
Engages K-12 students in authentic investigation of STEM → 2 activities	Engages K-12 students individually and/or in teams to design solutions to STEM challenges → 2 activities	Provides K-12 students with an extended duration experience with real-world STEM → 3 activities

Figure 1. Types of NASA STEM Engagement Activities Included in Study

NASA K-12 STUDENT INVENTORY. This evaluation builds on the work of the FY22 evaluation to use and further test the outcome assessment instrument developed and piloted in FY22.

The FY23 administration included direct collaboration with NASA K-12 Engagement Activity Managers from nine activities who shared links to the online instrument in spring and summer 2023 at the conclusion of their activities. A total of 1,376 participants responded. Exploratory Factor Analysis was used to test construct validity of the instrument and reduce the variables into factors.

ACTIVITY MANAGER DISCUSSIONS. Fourteen NASA STEM Engagement Activity Managers participated in initial study discussions to learn about the evaluation. Nine activities of various types participated in the study (Error! Reference source not found.). Meetings were held after data collection to review the activity-specific Evaluation Memos (see Figure 4) and discuss recommendations to ensure that the evaluation provided useful information.
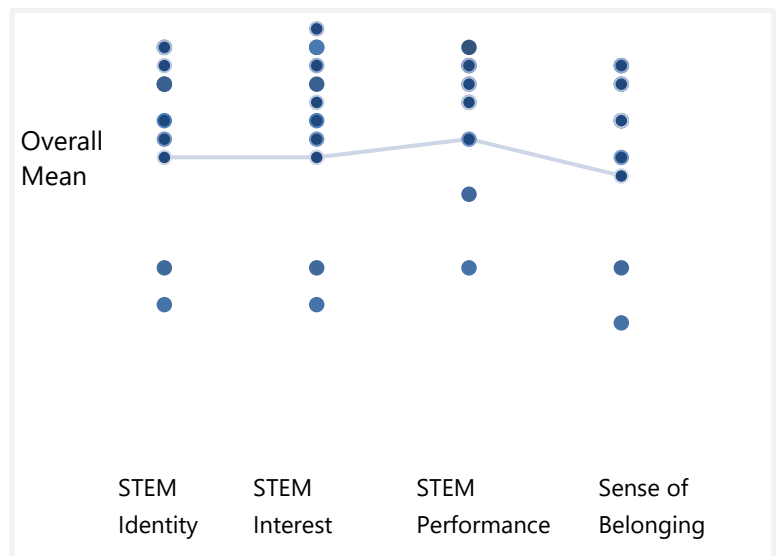

Figure 3. STEM Outcome Ratings by Activity of Youth Participants of NASA STEM Engagement Activities

FINDINGS

STUDENT OUTCOMES. Each dot in Figure 3 shows the average rating for each Engagement Activity. The line shows the average across the nine NASA STEM Engagement Activities that participated in the study. High levels of STEM Identity, STEM Interest, STEM Performance and Sense of Belonging are seen across the group. The average ratings on the scales ranged from 3.1 to 3.3; between agree a little (3) and agree a lot (4).

The mean (i.e., average) scores of two activities were lower than of the others and of the overall group average. These two activities predominantly serve students from groups historically underrepresented

and underserved in STEM. Scores indicate students from these two activities are not (yet) confident in their skills, feel like they belong in STEM, or see themselves as STEM people.

The highest average STEM outcome scores in terms of STEM Identity, STEM Interest, STEM Performance, and Sense of Belonging were evident among youth attending Summer Institutes/Camps. STEM Challenges/Competitions were second highest, and STEM Programs the lowest, ranging around the agree a little rating.

PSYCHOMETRIC ANALYSIS. Based on statistical analyses, feedback from an expert review panel convening, and previous research, the NASA K-12 Student STEM Inventory was shortened from 37 to 19 items (Figure 4). Students in grades 9-12 have the option to answer three additional items to provide demographic information using the categories identified for federal data collection.

STEM IDENTITY	STEM INTEREST	STEM PERFORMANCE	SENSE OF BELONGING
Rating Scale: Disagree a lot (1); Disagree a little (2); Agree a little (3); Agree a lot (4)			
• My parents or guardians think I am good at STEM • My teachers think I am good at STEM • My friends think I am good at STEM	• I see myself as a STEM person • I like learning about STEM • I like to solve STEM problems • I think of STEM things to try out • I get excited about doing STEM projects (originally self-efficacy scale)	• I am a good team member when I work in a group on a STEM project • I can finish a project by its due date • When a project does not work out I can think of other ways to do it • I can be the leader of a team working on a project	• I feel like I fit in within the NASA program
PRE-EXISTING STEM INTEREST	STEM ROLE MODEL	ACTIVITY OUTCOME	STEM CAREER INTEREST
• How often do you do STEM activities in your free time outside of your science class? (never, rarely (less than monthly) monthly, weekly daily) • What made you first become interested in STEM? (short answer)	• Does an adult in your life have a STEM job? (Y/N/Not sure)	• Please describe what you learned about NASA. (short answer)	• What kind of job do you see yourself doing in the future? (short answer)
DEMOGRAPHICS			
• What is your current grade level? (9-12 grade, demographic questions, if not, survey ends) • What is your gender? (M/F/do not wish to provide) • What is your ethnicity? (Hispanic or Latino, Not Hispanic or Latino, Do not wish to provide) • What is your race? (select all that apply: American Indian or Alaska Native, Asian, Black or African American, Native Hawaiian or other Pacific Islander, White, Do not wish to provide)			

Figure 4. FY23 NASA K-12 Student STEM Inventory, Including Response Option and Format

The Inventory measures STEM Identity (other people's assessment of a person's STEM competence), STEM Interest (interest to learn and try STEM activities), and STEM Performance (engagement and leadership in STEM projects). The inventory also asks about Pre-existing STEM Interest, STEM Role Models, Career Interest, and Sense of Belonging in the NASA activity.

USEFULNESS OF EVALUATION FOR ACTIVITY

IMPROVEMENT. Activity Managers each received an Evaluation Memo that included a short description of the activity and summarized participant outcome data (see example

> As someone who doesn't come from an evaluation background, I think it's still relatively easy to read.

shown in Figure 5). Activity Managers found the memo useful and appreciated receiving specific feedback and results. Recommendations to improve the evaluation process include allowing more time for distributing the surveys, allowing for flexibility for survey launch to align with activity timelines, and additional supports for the interpretation of activity-specific student STEM outcomes.
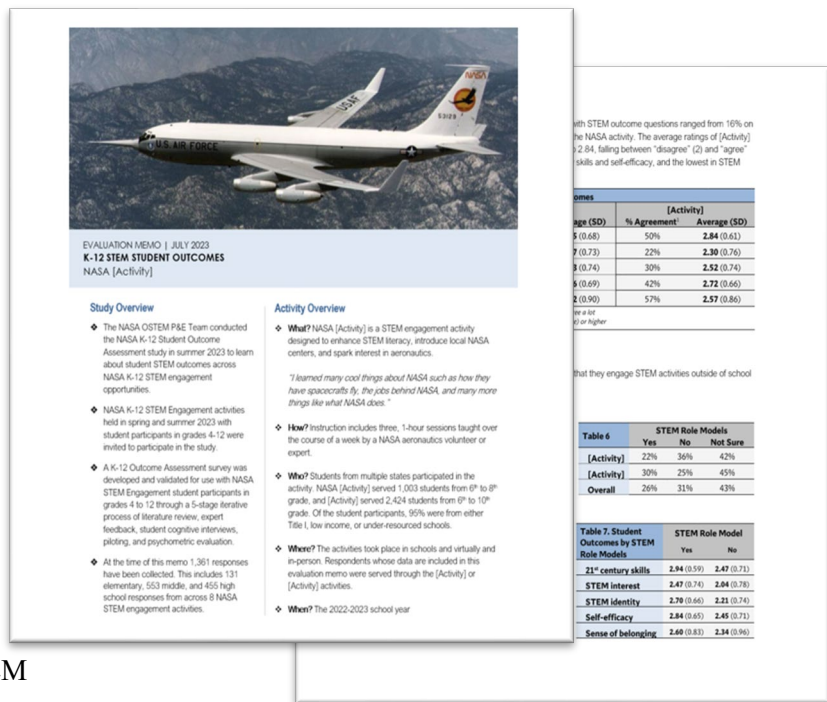

Figure 5. Evaluation Memo Sample

KEY TAKEAWAYS

STUDY GUIDING TOPICS	FINDINGS	RECOMMENDATION
STEM OUTCOMES	• High ratings of STEM Identity, STEM Interest, STEM Performance, and Sense of Belonging were reported by the over 1,000 participants of the nine activities included in this study. • Participants of Summer Camps/Institutes offered the highest ratings on all scales.	Variability among activities and activity types supports the recommendation for a systematic data collection method (e.g., Activity Manager Questionnaire).
UTILITY OF K-12 STUDENT STEM INVENTORY	• Study findings confirm the utility of the NASA K-12 STEM Inventory to assess outcomes for participants in grades 4-12 across different types of NASA K-12 STEM engagements.	Continue to collect student outcome data from NASA K-12 STEM Engagement Activities.
UTILIZATION OF FINDINGS	• Initial meetings with Activity Managers highlighted the importance of building relationships to understand hesitancy regarding evaluation and allowed for targeted modifications or enhancements to support engagement in evaluation activities. • Activity-specific feedback provided valuable information to Activity Managers and evaluators.	Continue to adapt evaluation processes based on feedback.

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