CALL TO ACTION: THE FOUNDATIONS FOR EVIDENCE-BASED POLICYMAKING ACT OF 2018

The *Foundations for Evidence-Based Policymaking Act of 2018* (Public Law No. 115-435) (Evidence Act) calls upon all Chief Financial Officer (CFO) Act agencies to build and use evidence for decision making. Specifically, the Evidence Act requires each CFO agency to concretize and operationalize "a systematic plan for identifying and addressing policy questions relevant to the programs, policies, and regulations of the agency." In support of the Evidence Act and related guidance from the Office of Management and Budget (OMB Circular No. A-11, OMB M-19-23, OMB M-20-12, and OMB M-21-27), this report brief presents the NASA Office of STEM Engagement (OSTEM) Learning Agenda for FY 2019– FY 2021, which aligns with and serves as amplification to the Agency's strategic plan and learning agenda.

ENACTING A CULTURE OF EVIDENCE

In alignment with federal government evidence-based policy initiatives, Section 203 (a) (3) of the Space Act, and NASA's goals and priorities for STEM engagement (NASA Strategic Plan), NASA's OSTEM undertook a rigorous iterative development process to establish the first OSTEM Learning Agenda. The FY 2019-FY 2021 Learning Agenda serves as the foundational document for building a culture of learning and continual improvement within NASA's OSTEM. The implementation of the Learning Agenda provides a systematic approach for building and using new knowledge about project and operational performance for evidence-based decision making and continual improvement.

DEVELOPMENT OF THE OSTEM LEARNING AGENDA

The FY 2019–FY 2021 Learning Agenda development process was guided by a theory of change, which posits: If strategic Learning Questions are developed, Learning Activities are conducted to answer the Learning Questions, and the evidence gathered from the Learning Activities is used to create Learning Products, then the Office of STEM Engagement will be better equipped with evidence to make budgetary, programmatic, and operational decisions. The intended long-term change (outcome) of implementing this Learning Agenda is to develop a culture of learning and continual improvement within NASA's OSTEM.
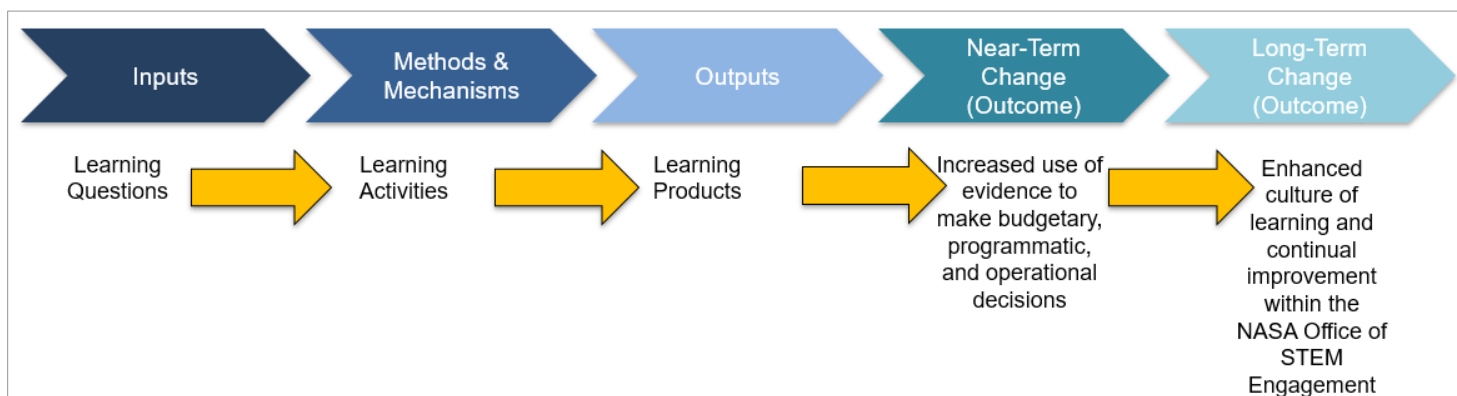

Figure 1. NASA's Office of STEM Engagement Learning Agenda Theory of Change.

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There was extensive engagement and collaboration with internal and external stakeholders in the execution of the FY 2019–FY 2021 Learning Agenda. These stakeholders were provided an overview of the Learning Agenda and invited to multiple meetings where there were opportunities to shape the direction of Learning Questions, provide input into the development of the evidence-based decision-making process, and give guidance on evaluation of progress toward meeting Learning Agenda goals and objectives. The primary source of engagement was Expert Review Panels (ERP), comprised of nationally recognized experts, where participants were engaged at strategic decision points to provide recommendations and feedback on Learning Questions, Learning Activities, Learning Products, and the use of Learning Products for evidence-based decisions. NASA's OSTEM Learning Agenda Collaborative Development and Execution Process was followed in the execution of the FY 2019–FY 2021 Learning Agenda.

The NASA OSTEM FY 2019–FY 2021 Learning Agenda Version 1 (FY 2019–FY 2020) was created between October 2017–August 2018 using the following three development steps (see Figure 2).
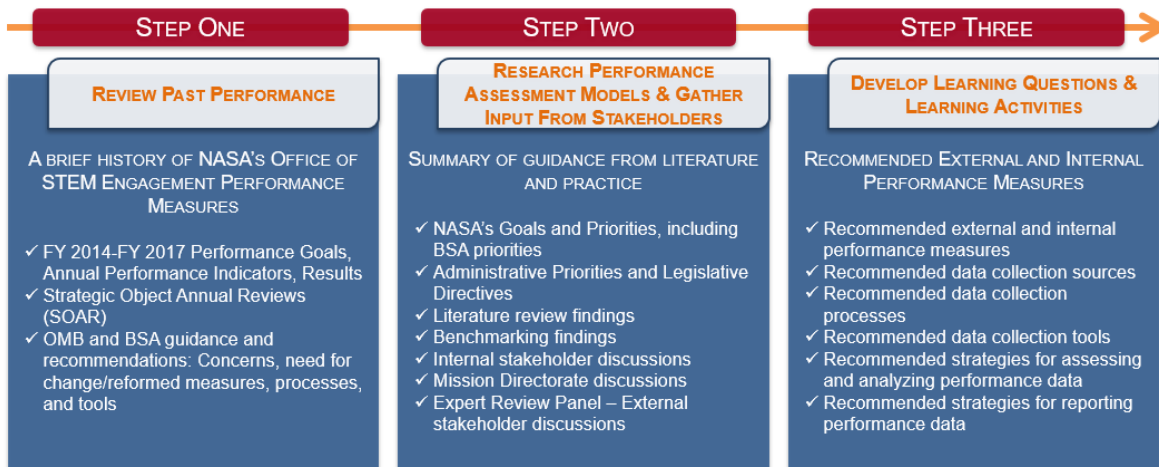
STEP ONE	STEP TWO	STEP THREE
REVIEW PAST PERFORMANCE	**RESEARCH PERFORMANCE ASSESSMENT MODELS & GATHER INPUT FROM STAKEHOLDERS**	**DEVELOP LEARNING QUESTIONS & LEARNING ACTIVITIES**
A BRIEF HISTORY OF **NASA**'S OFFICE OF **STEM** ENGAGEMENT PERFORMANCE MEASURES ✓ FY 2014–FY 2017 Performance Goals, Annual Performance Indicators, Results ✓ Strategic Object Annual Reviews (SOAR) ✓ OMB and BSA guidance and recommendations: Concerns, need for change/reformed measures, processes, and tools	SUMMARY OF GUIDANCE FROM LITERATURE AND PRACTICE ✓ NASA's Goals and Priorities, including BSA priorities ✓ Administrative Priorities and Legislative Directives ✓ Literature review findings ✓ Benchmarking findings ✓ Internal stakeholder discussions ✓ Mission Directorate discussions ✓ Expert Review Panel – External stakeholder discussions	RECOMMENDED EXTERNAL AND INTERNAL PERFORMANCE MEASURES ✓ Recommended external and internal performance measures ✓ Recommended data collection sources ✓ Recommended data collection processes ✓ Recommended data collection tools ✓ Recommended strategies for assessing and analyzing performance data ✓ Recommended strategies for reporting performance data

Figure 2. NASA's Office of STEM Engagement Learning Agenda Version 1 (FY 2019–FY 2020) Development Process.

Following the development of the NASA OSTEM FY 2019–FY 2020 Learning Agenda, it was implemented using the three execution steps illustrated in Figure 3.
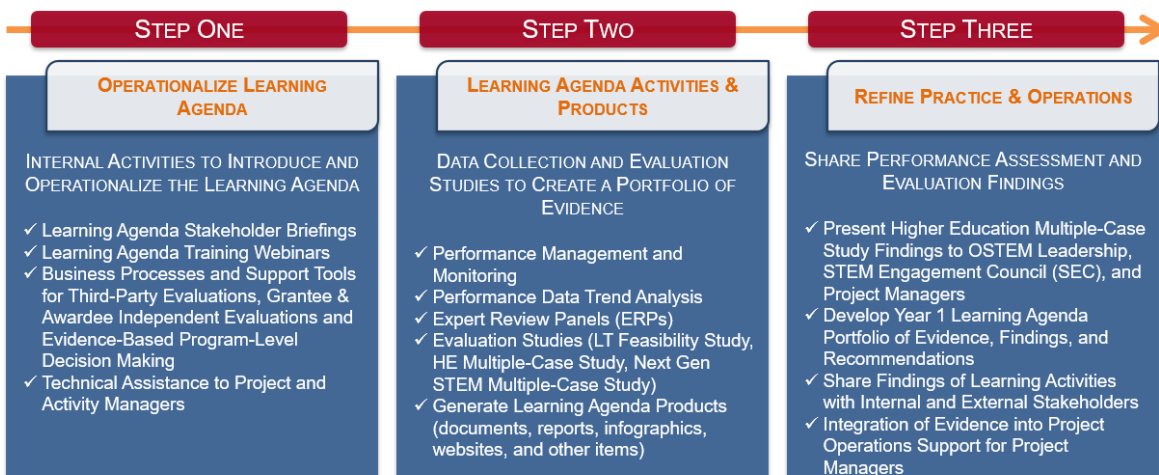
STEP ONE	STEP TWO	STEP THREE
OPERATIONALIZE LEARNING AGENDA	**LEARNING AGENDA ACTIVITIES & PRODUCTS**	**REFINE PRACTICE & OPERATIONS**
INTERNAL ACTIVITIES TO INTRODUCE AND OPERATIONALIZE THE LEARNING AGENDA ✓ Learning Agenda Stakeholder Briefings ✓ Learning Agenda Training Webinars ✓ Business Processes and Support Tools for Third-Party Evaluations, Grantee & Awardee Independent Evaluations and Evidence-Based Program-Level Decision Making ✓ Technical Assistance to Project and Activity Managers	DATA COLLECTION AND EVALUATION STUDIES TO CREATE A PORTFOLIO OF EVIDENCE ✓ Performance Management and Monitoring ✓ Performance Data Trend Analysis ✓ Expert Review Panels (ERPs) ✓ Evaluation Studies (LT Feasibility Study, HE Multiple-Case Study, Next Gen STEM Multiple-Case Study) ✓ Generate Learning Agenda Products (documents, reports, infographics, websites, and other items)	SHARE PERFORMANCE ASSESSMENT AND EVALUATION FINDINGS ✓ Present Higher Education Multiple-Case Study Findings to OSTEM Leadership, STEM Engagement Council (SEC), and Project Managers ✓ Develop Year 1 Learning Agenda Portfolio of Evidence, Findings, and Recommendations ✓ Share Findings of Learning Activities with Internal and External Stakeholders ✓ Integration of Evidence into Project Operations Support for Project Managers

Figure 3. NASA OSTEM Learning Agenda Execution Process.

LEARNING AGENDA QUESTIONS & REFINEMENT

The FY 2019-FY 2020 Learning Agenda development process resulted in the creation and prioritization of three primary Learning Questions. During the execution of the FY 2019-FY 2020 Learning Agenda, additional evidence and feedback from stakeholders informed the revision of one Learning Agenda Question and the addition of a fourth Learning Agenda Question. In FY 2021, Learning Agenda Question 3 was revised to align with the Agency focus on broadening participation of students from groups historically underrepresented and underserved in NASA STEM Engagement activities, as outlined in the updated strategy for NASA STEM Engagement, and a new Learning Agenda Question was added. The fourth Learning Question was added in response to stakeholder feedback, which illuminated the need for a targeted focus on NASA's STEM Engagements' K-12 programming and activities – resulting in a more inclusive and holistic approach to examining the NASA STEM Engagement portfolio.

NASA's OSTEM's commitment to evidence-building practices resulted in the following Learning Questions aligned to NASA's priorities for STEM Engagement and focus areas where evidence is needed to inform strategy and programmatic decisions.

ALIGNMENT OF LEARNING AGENDA QUESTIONS WITH NASA OSTEM FOCUS AREAS

FOCUS AREAS	LEARNING AGENDA QUESTIONS
CONTRIBUTIONS TO NASA'S MISSIONS & WORK	**Learning Agenda Question 1:** To what extent are NASA's STEM engagement investments contributing to NASA's missions and work?
DIVERSITY OF THE FUTURE STEM WORKFORCE	**Learning Agenda Question 2*:** How have NASA STEM Engagement investments broadened participation of historically underrepresented and underserved groups in STEM fields in NASA STEM Engagement activities?
PERFORMANCE ASSESSMENT & EVALUATION	**Learning Agenda Question 3:** To what extent have enhancements to STEM engagement performance assessment and evaluation been implemented?
UNDERSTANDING K-12 STEM ENGAGEMENT INVESTMENTS	**Learning Agenda Question 4:** What are effective strategies to support and measure NASA STEM Engagement K-12 investments' ability to spark student interest in STEM?

*Original (Version 1) Learning Question 2: To what extent are NASA's STEM engagement investments contributing to the diversity of the future aerospace industry's STEM workforce?

LEARNING ACTIVITIES

Once the Learning Questions were established, appropriate Learning Activities, including strategies, tasks, methods, and mechanisms were developed to answer the Learning Questions. Learning Activities were scaled to the stage of project execution and the level of investment (see Figure 4).
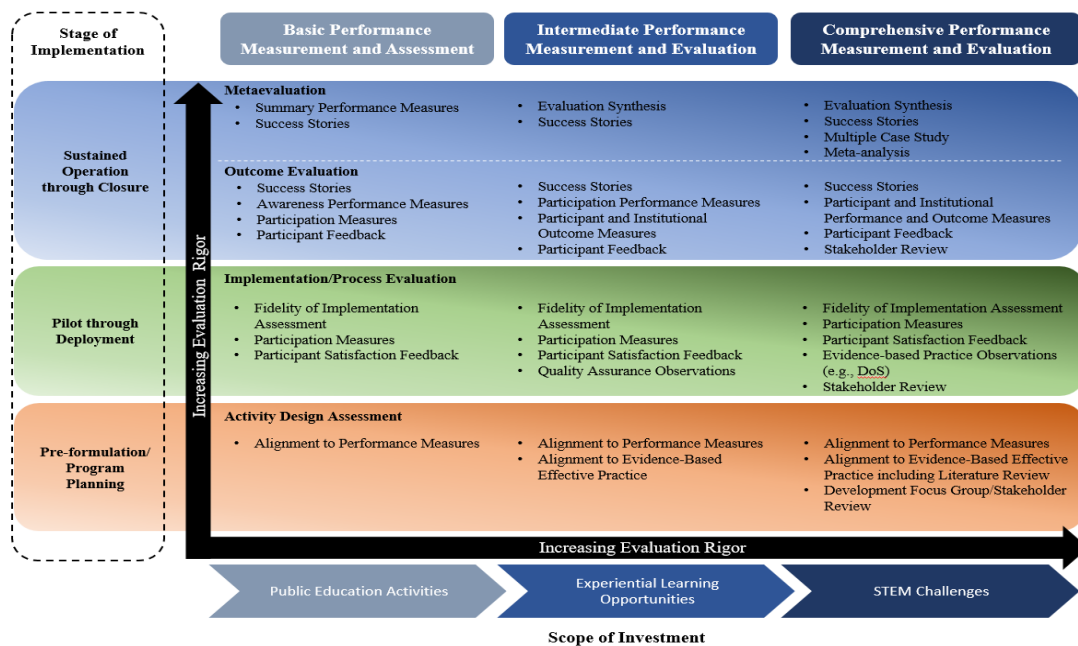
Figure 4. Tiered Approach to Performance Assessment and Evaluation.

EVIDENCE-BASED DECISION-MAKING PROCESS – ENHANCING EVIDENCE USE

To facilitate the use of Learning Products, including each Learning Question's portfolio of evidence to inform budgetary, policy, programmatic, and operational decisions, NASA's OSTEM created an evidence-based decision-making process, which was piloted in the first year of the Learning Agenda implementation. The process was created after reviewing government and agency policies and priorities and evidence-based decision-making documents of other federal agencies and private organizations. The evidence-based decision-making process was further refined in FY 2020 to include additional steps to the continual learning cycle to better facilitate use of learning products. The refined and current version and corresponding clarifying descriptions are presented in Figure 5 and Table 1, respectively.
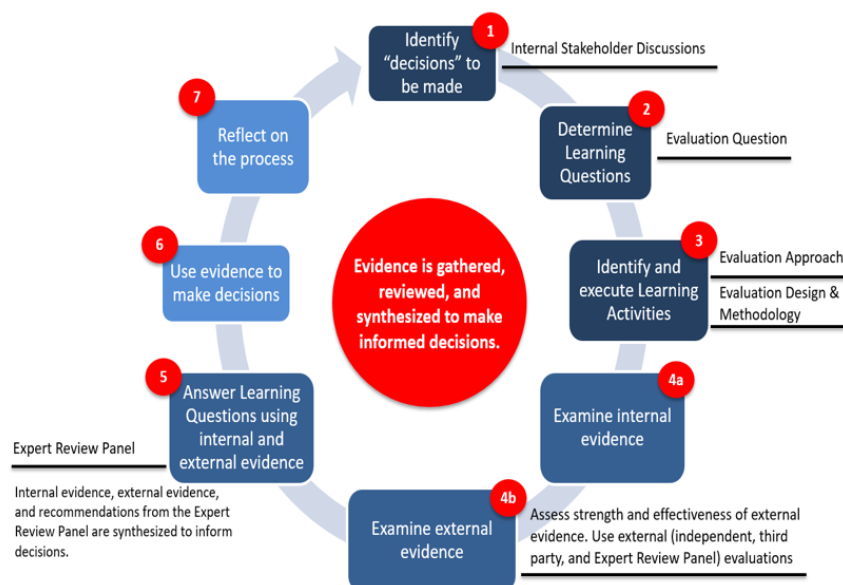
Figure 5. Evidence-Based Decision-Making Process.

Table 1. Evidence-Based Decision-Making Process Steps

Action	Explanation
1. Identify "Decisions" To Be Made	Relevant stakeholders gather to identify the decisions to be made. Identify how decisions align with overall strategic goals.
2. Determine Learning Questions	Determine a strategy for how to make the decisions; plan should include Learning Questions.
3. Identify and Execute Learning Activities	Determine appropriate internal and external Learning Activities. Execute Learning Activities.
4a. Examine Internal Evidence	*(Note: Examination of internal and external evidence may occur concurrently, sequentially, or in reverse order.)* Conduct formative and summative studies to examine internal evidence using qualitative and quantitative data.

4b. Examine External Evidence	Gather and examine relevant external evidence using data collected from activity and program evaluations. The value of the external evidence will be highly variable; therefore, it should be critically appraised.
	
	Critically appraise external evidence. Consider two underlying facets of the external evidence:
	  a. Strength of Evidence
	    – How rigorously has the program, practice, or policy been evaluated?
	    – How strong is the evidence in determining that the program or policy is producing the desired outcomes?
	    – How much evidence exists to determine that something other than this program or policy is responsible for producing the desired outcomes?
	  b. Effectiveness
	    – Is this program, practice, or policy producing desired outcomes?
	    – Is it producing non-desirable outcomes?

5. Answer Learning Questions Using Internal and External Evidence	The two sources of information (internal and external) may be supportive, non-supportive, or conflicting. How the decision is made when non-supportive or conflicting will depend on multiple factors. Options include comparing the internal evidence to the external evidence. Alternatively, it may be determined that the external evidence is not sufficiently convincing, and the internal evidence may be given more weight. The conflict between the internal and external evidence may be discussed with stakeholders and/or an expert review panel in a manner that enables the stakeholders to weigh in on the decision-making process.
6. Use Evidence To Make Decisions	Upon completion of Step 5, a decision will be made. Evaluate extent to which decision aligns with objectives and rationale defined in Step 1.
7. Reflect On Process	Once the decision has been made, the process should be considered and critically evaluated to identify opportunities for improvement.

There were several evidence-building activities that were associated with each of the Learning Agenda Questions. These were characterized as Learning Activities and findings from each provided a rich evidence base for evaluating progress toward NASA's annual performance goals and targets. A summary of the key evidence-building activities associated with the four Learning Agenda Questions and their respective sub-questions are presented below.

LEARNING AGENDA QUESTION 1: TO WHAT EXTENT ARE NASA'S STEM ENGAGEMENT INVESTMENTS CONTRIBUTING TO NASA'S MISSIONS AND WORK?

a. What characteristics define students' contributions to NASA's aeronautics, space, and science missions and work in exploration and discovery?
b. To what extent are NASA student experiences aligned with evidence-based, high-quality student engagement?
c. How can NASA develop data collection, analysis, and reporting mechanisms to better assess NASA STEM engagement activities' contributions to NASA missions and work?

DEVELOPMENTAL HYPOTHESIS: If student contributions to NASA's missions and work are characterized, then current levels of contribution can be assessed, and performance assessment and evaluation strategies can be more clearly defined. As a result, the Office of STEM Engagement will be better equipped to prioritize STEM engagement investments that provide opportunities for students to contribute to NASA's missions and work and share effective practices across the portfolio.

STEM ENGAGEMENT FOCUS: Create unique opportunities for students and the public to contribute to NASA's work in exploration and discovery.

KEY LEARNING ACTIVITIES:
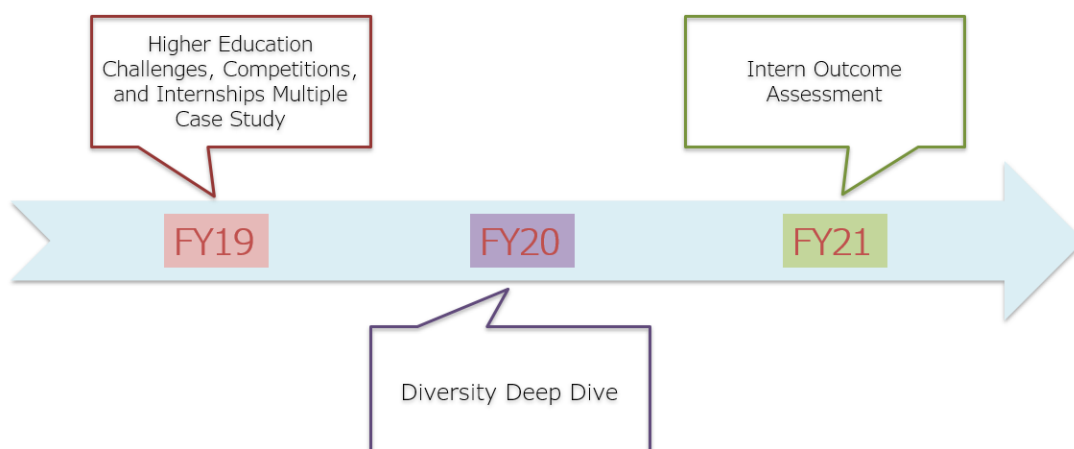
Higher Education Challenges, Competitions, and Internships Multiple Case Study — FY19

Diversity Deep Dive — FY20

Intern Outcome Assessment — FY21

KEY IMPACTS: Three key Learning Activities mapped to Learning Agenda Question 1 across FY19, FY20, and FY21: 1) FY19 Higher Education Challenges, Competitions, and Internships Multiple Case Study; 2) FY20 Diversity Deep Dive; and 3) FY21 Intern Outcome Assessment. Each Learning Activity generated outcomes, which served as new knowledge and foundational information for additional evidence-building activities that enhanced the growing evidence base the NASA OSTEM continues to leverage for decision making. Significant key impacts resulting from each Learning Activity are discussed below:

- The FY19 Higher Education Challenges, Competitions, and Internships Multiple Case Study enabled OSTEM to concretize the definition of "Contribution" to NASA's mission. As a result of the study, OSTEM was able to define and operationalize a clear, shared definition of contributions to NASA's mission. NASA's OSTEM was also able to develop metrics to support the assessment of the Office's performance goal related to R&D products.
- In FY20, the Diversity Deep Dive study identified evidence-based effective practices for broadening participation of students from groups historically underrepresented in STEM. Notably, the findings from the Diversity Deep Dive study enabled the development of the *NASA OSTEM Broadening Student Participation Action Plan*.
- Findings from the FY20 Diversity Deep Dive study informed the development of the FY21 Intern Outcome Assessment, which served a critical role in the development of the Agency Equity Action Plan and the Agency Priority Learning Agenda Question focused on internships.

LEARNING AGENDA QUESTION 2: HOW HAVE NASA STEM ENGAGEMENT INVESTMENTS BROADENED PARTICIPATION OF HISTORICALLY UNDERREPRESENTED AND UNDERSERVED GROUPS IN STEM FIELDS IN NASA STEM ENGAGEMENT ACTIVITIES?

a. Does NASA provide higher education challenges, competitions, internships, and fellowships to students across all institutional categories and levels at percentages that meet or exceed the national percentages of science and engineering college graduates?

b. In comparison to the prior fiscal year, to what extent do gaps decrease between percentages of (1) racially or ethnically underrepresented and non-underrepresented students; (2) female and male students; and (3) persons with disabilities and persons without disabilities who applied and/or received internships and fellowships?

c. How and to what extent has MUREP achieved its intended goals and objectives?

d. To what extent are NASA interns entering the NASA or other STEM workforce or entering a STEM-focused post-graduate academic area?

e. How can NASA OSTEM provide STEM engagement opportunities that are adaptable to the unique needs and contextual factors of various beneficiaries?

DEVELOPMENT HYPOTHESIS: If data is collected to better understand the demographic characteristics of higher education awardees and how NASA STEM Engagement investments in higher education awards contribute to the diversity of the future aerospace industry's STEM workforce, then the Office of STEM
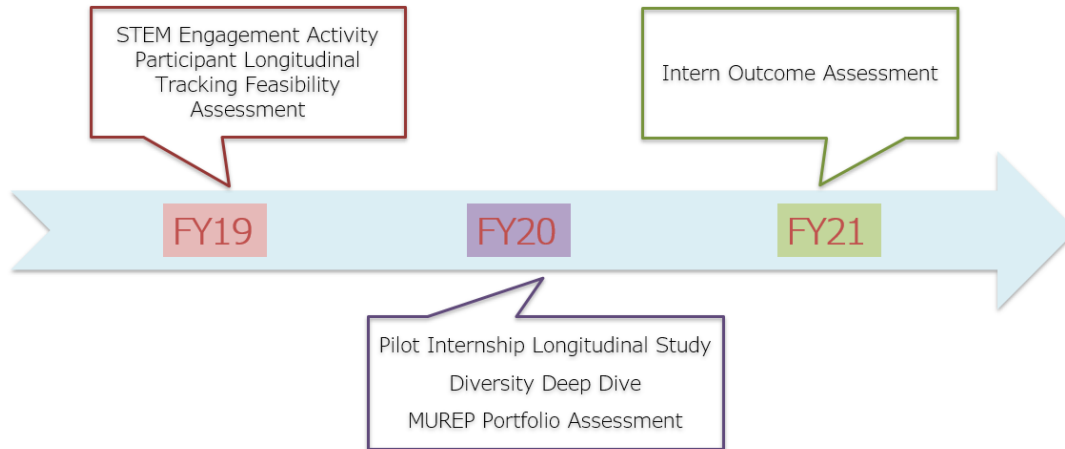
Engagement will be better equipped to make budgetary, programmatic, and operational decisions regarding the design, execution, and focus of future investments.

STEM ENGAGEMENT FOCUS: Build a diverse future STEM workforce by engaging students in authentic learning experiences with NASA's people, content, and facilities.

KEY LEARNING ACTIVITIES:

KEY IMPACTS: Five key Learning Activities were developed to align with Learning Agenda Question 2 across FY19, FY20, and FY21: 1) FY19 STEM Engagement Activity Participant Longitudinal Tracking Feasibility Assessment; 2) FY20 Pilot Internship Longitudinal Study; 3) FY20 Diversity Deep Dive; 4) FY20 MUREP Portfolio Assessment; and 5) FY21 Intern Outcome Assessment. The following section will focus on the key impacts derived from the studies not yet discussed above for Learning Agenda Question 1:

– Results from the FY19 STEM Engagement Activity Participant Longitudinal Tracking Feasibility Assessment informed the design of an enhanced data management system as well as improved upon the quality of performance assessment and evaluation. Another key outcome of this Learning Activity was the Pilot Internship Longitudinal Study that was designed to assess long-term outcomes aligned to NASA STEM Engagement goals and objectives.

– In FY20, the Pilot Internship Longitudinal Study compared multiple methodologies to determine which would be most successful in understanding the extent to which the NASA Internship Program attracted students to careers in STEM and contributed to the mission of helping to develop a skilled and diverse future STEM workforce. This study resulted in the methodological approach with which OSTEM ultimately employed to understand impacts of NASA student supports on the present and future STEM workforce.

– The FY20 MUREP Portfolio Assessment was the first program-level evaluation OSTEM conducted on one of its four Congressionally funded projects. This study established an evidence base for a future outcome assessment focused on the role of partnerships and Minority-Serving Institutions (MSIs) and the constructs related to student STEM identity, sense of belonging, self-efficacy, and how MSIs recruit and retain students from groups historically underrepresented in STEM.
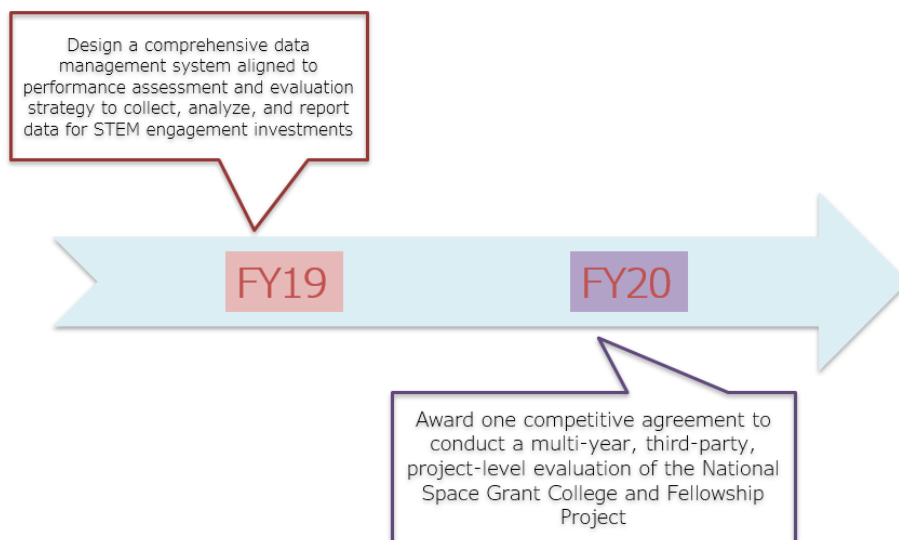
a. To what extent has NASA designed a data management system aligned to performance assessment and evaluation strategy to collect, analyze, and report data for STEM engagement investments been?

b. To what extent has NASA developed an evaluation plan for outcome evaluation of higher education and challenges and competitions?

c. To what extent has NASA increased transparency of STEM engagement performance data and reporting?
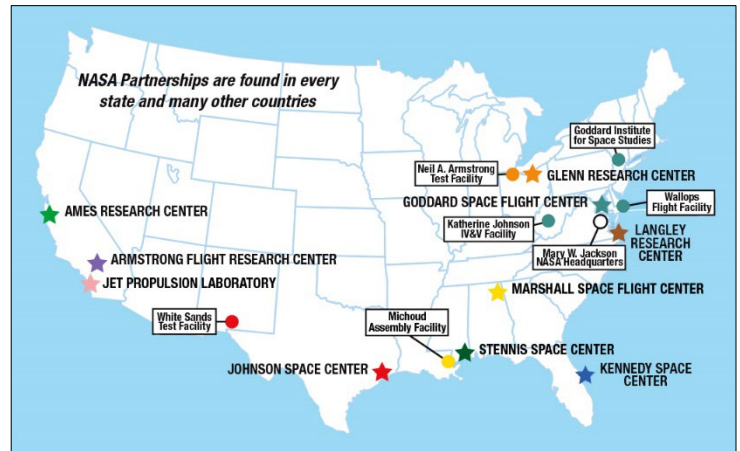
DEVELOPMENT HYPOTHESIS: If enhancements to STEM engagement performance assessment and evaluation have been implemented, then the Office of STEM Engagement will be better equipped to collect and use evidence for budgetary, programmatic, and operational decisions.

STEM ENGAGEMENT FOCUS: Align to the federal government evidence-based policy initiatives and increased need for rigorous performance measures. Move from basic quantitative output performance measures to more robust outcome measures and develop a portfolio of evidence for use in decision making.

KEY LEARNING ACTIVITIES:

Design a comprehensive data management system aligned to performance assessment and evaluation strategy to collect, analyze, and report data for STEM engagement investments

FY19   FY20

Award one competitive agreement to conduct a multi-year, third-party, project-level evaluation of the National Space Grant College and Fellowship Project

KEY IMPACTS: Learning Agenda Question 3 included two key Learning Activities, framed in the format of a "call to action." In FY19, NASA's OSTEM set out to design a comprehensive data management system aligned to its performance assessment and evaluation strategy to collect, analyze, and report data for STEM engagement investments. Then, in FY20, NASA's OSTEM went forth to award a

competitive agreement to conduct a multi-year, third-party, project-level evaluation of the National Space Grant College and Fellowship Project. In addition to enabling NASA's OSTEM to establish rigorous performance measures and collect and use evidence for budgetary, programmatic, and operational decisions, these Learning Activities also resulted in the following key outcomes:

– The development of performance assessment and evaluation requirements and recommendations to support the development of an enterprise-wide performance management system—the NASA STEM Gateway.
– Inclusion of language and practices aligned to the federal government evidence-based policy initiatives in all of the NASA OSTEM solicitations.

LEARNING AGENDA Question 4: WHAT ARE EFFECTIVE STRATEGIES TO SUPPORT AND MEASURE NASA STEM ENGAGEMENT K-12 INVESTMENTS' ABILITY TO SPARK STUDENT INTEREST IN STEM?

a. In what ways are NASA STEM engagement K-12 activities aligned to NASA's aeronautics, space, and/or science missions?
b. How do NASA's STEM engagement K-12 activities serve national and regional STEM ecosystems?
c. How do NASA's STEM engagement K-12 activities attract diverse groups of students to STEM?
d. How can NASA develop data collection, analysis, and reporting mechanisms to better assess the extent to which K-12 STEM engagement activities' spark students' interest in STEM?

DEVELOPMENT HYPOTHESIS: If NASA STEM Engagement K-12 programs utilize evidence-based practices for engaging students in authentic STEM experiences, student interest in STEM will be "sparked" (ignite and increase).

STEM ENGAGEMENT FOCUS: Build a diverse future STEM workforce by engaging students in authentic learning experiences with NASA's people, content, and facilities.

KEY LEARNING ACTIVITIES:

K-12 Internal Strategic Assessment

NextGen STEM Pilot Outcome Study
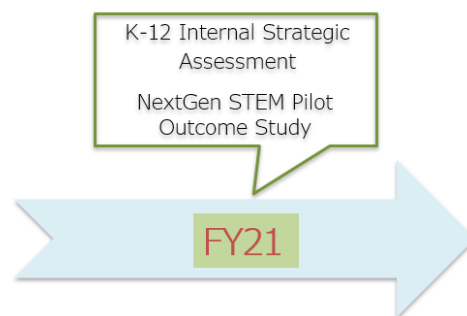
FY21

KEY IMPACTS: In FY21, the fourth Learning Agenda Question was added in response to stakeholder feedback, which illuminated the need for a targeted focus on NASA STEM Engagements' K-12
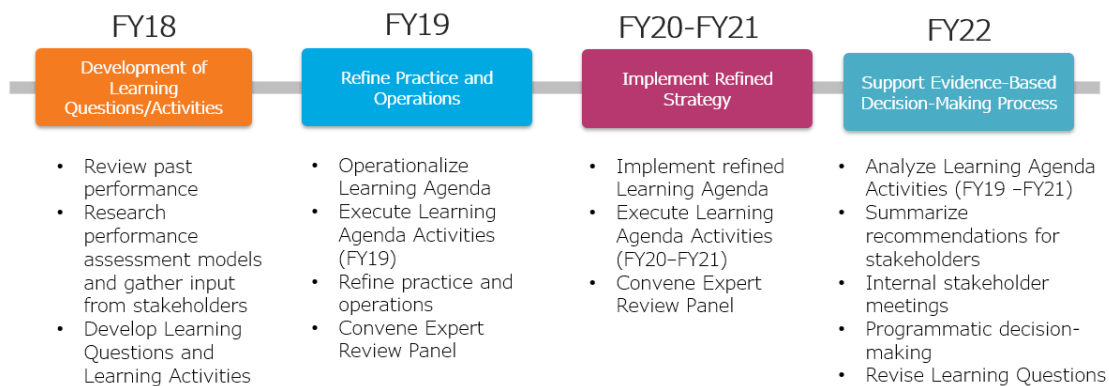
programming and activities. By intentional design, previous evidence-building activities focused on higher education. Accordingly, the addition of Learning Agenda Question 4 resulted in a more inclusive and holistic approach to examining the NASA STEM Engagement portfolio. Two key Learning Activities mapped to Learning Agenda Question 4: 1) FY21 K-12 Internal Strategic Assessment, and 2) FY21 NextGen STEM Pilot Outcome Study. Below is a discussion of their key impacts.

– In FY21, the K-12 Internal Strategic Assessment resulted in the development of a NASA K-12 STEM Engagement theory of change and logic model.
– The FY21 NextGen STEM Pilot Outcome Study was conducted to develop data collection, analysis, and reporting mechanisms to better assess the extent to which K-12 STEM engagement activities spark students' interest in STEM. This Learning Activity provided a foundational knowledge base for NASA's OSTEM to identify common methods for assessing K-12 student outcomes and to better understand the extent to which NASA provides STEM Engagement opportunities (e.g., challenges, competitions, etc.) for K-12 students.

AD ASTRA – WHERE DO WE GO FROM HERE

The FY 2019-FY 2021 Learning Agenda has set the foundation for institutionalizing a culture of evidence across the NASA OSTEM enterprise. It has served as a key document for building a culture of learning and continual improvement within NASA's OSTEM. Implementation of the Learning Agenda has provided a systematic approach for building and using new knowledge about project and operational performance for evidence-based decision making and continual improvement.

In reflection across the years, there has been tremendous shift in the perceptions and use of evidence across the NASA OSTEM enterprise. Throughout the NASA OSTEM enterprise, project key personnel and leaders are actively building and using evidence for budgetary, programmatic, and operational decisions regarding the design, execution, and focus of existing and future STEM Engagement investments.

FY18	FY19	FY20-FY21	FY22
Development of Learning Questions/Activities	**Refine Practice and Operations**	**Implement Refined Strategy**	**Support Evidence-Based Decision-Making Process**
• Review past performance • Research performance assessment models and gather input from stakeholders • Develop Learning Questions and Learning Activities	• Operationalize Learning Agenda • Execute Learning Agenda Activities (FY19) • Refine practice and operations • Convene Expert Review Panel	• Implement refined Learning Agenda • Execute Learning Agenda Activities (FY20–FY21) • Convene Expert Review Panel	• Analyze Learning Agenda Activities (FY19 –FY21) • Summarize recommendations for stakeholders • Internal stakeholder meetings • Programmatic decision-making • Revise Learning Questions

From the strength of this foundation, NASA OSTEM will continue to enhance its role in the Agency by applying evidence generated from the FY 2019-FY 2021 Learning Agenda and leveraging OSTEM's Learning Agenda expertise to support the development of the next multi-year OSTEM Learning Agenda, Agency Strategic Plan, and Agency-Level Learning Agenda. Without a doubt, the NASA OSTEM Learning Agenda is a key tool to the continued work of identifying priorities which will enhance decision and policy making through strategic systematic evidence-building, across the OSTEM enterprise and the Agency, effectively continuing to amplify NASA's long held commitment to strong evidence-building practices.