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Background

On June 25 and 26, 2018, 211 STEM education leaders, 176 of whom were representatives from the 50 states, the District of Columbia, Puerto Rico, the U.S. Virgin Islands, Guam, the Northern Mariana Islands, and several tribal territories[1], gathered in Washington, D.C. for the first State-Federal STEM Summit. On Day 2 of the Summit, these representatives from the K–16 education, business, and policy sectors met at the National Science Foundation to share their individual viewpoints[2] on the impact of the 2013-2018 Federal 5-Year STEM Education Strategic Plan and priorities for the future Plan.[3] These reflections are intended to inform the direction of the 2018–2023 STEM Education Strategic Plan.

With that purpose in mind, three substantive discussions were held on June 26 to address the following over-arching questions:

1. What was the impact of the past (2013–2018) Federal Five-Year STEM Education Strategic Plan on states' STEM programs and policies?

2. What are the emergent trends and priorities of the STEM Community, and how might they factor in to the prospective 2018–2023 Federal Five-Year STEM Education Strategic Plan?

3. What is the federal role and responsibility in supporting states' STEM education programs and policies?

In this report, we describe the Summit's proceedings and findings for each of the three discussion questions. For each question, we introduce the purpose of the discussion[4], present the major findings drawn from the data, and provide a detailed description of the themes and patterns that emerged. We close the report with a discussion of our concluding observations. The content of the conversations occasionally overlapped. For example participants talked about the federal role in supporting states' STEM education programs (Question 3) during their discussion about the STEM Aspirations (Question 2). In those cases, for ease of the reader in making sense of the findings, we report the results with the appropriate question topic. Our methodology for analyzing the data harvested from each discussion and the facilitator focus groups is discussed in Appendices C, D, and E for Discussion Questions 1, 2, and 3, respectively.

DISCUSSION OF QUESTION 1

What was the impact of the past (2013–2018) federal five-year STEM education strategic plan on states' STEM programs and policies?

The purpose of this discussion was to increase understanding of whether and to what degree participants were aware of the prior Strategic Plan and their perceptions of its impact. This

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1   For the purposes of this report, the word "state" should be understood to include states, commonwealths, territories, tribal communities, and all other relevant areas and jurisdictions.
2   This entire activity was managed consistent with the Federal Advisory Committee Act, 5 U.S.C. App., as amended. Only individual views were sought from the attendees.
3   For a detailed count of Summit participants by region and STEM leadership role, see Table 5 and Table 6 in Appendix B.
4   See the Facilitator Guide in Appendix C for a comprehensive description of the discussions' format and structure.

information will help the framers of the new Plan increase its relevance to a broad audience and ensure that it is better publicized. What were the Plan's successes, and how can they be amplified? What were its weaknesses, and how can they be avoided or overcome? Sixty minutes were allotted for this discussion: 5 minutes for introductions, 40 minutes to discuss Question 1, and 15 minutes for reflection and synthesis.

RESULTS OF QUESTION 1 DISCUSSION

Two key findings emerged from this discussion. We present these findings below, followed by a detailed description of the themes with illustrative quotes drawn from the data.

Note: In addition to responding to the guiding questions about the impact of the previous Plan, participants also commented on how it could be improved and the role of the Federal Government in that process. Because these ideas are more closely related to the third discussion question, they are included in the Key Findings section for Discussion Question 3.

Key Findings

- The majority of Summit participants had little or no awareness of the prior Strategic Plan. The few who did may have had roles that included state or national policy responsibilities, engagement in pursuit of federal funding, and/or location in an urban versus a rural setting.

- The prior Plan appeared to serve as a vehicle for providing general policy direction that facilitated statewide conversations, influenced states' STEM plans, or informed the development of programs or initiatives. Upon reflection during the Summit, some attendees could retrospectively see the connection between the prior Plan's goals and the direction of STEM programs in their states.

General Themes

The data we gathered fell into three thematic areas:

- Participants' awareness of the previous Plan

- Perceived utility of the previous plan

- Differences by state or role in views about the prior Plan

Each theme is discussed in more detail below. We note when a quote is known to have been made by a facilitator. Attribution is not given for comments made by a participant or those where the identity was not possible to determine.

Awareness of the previous Plan. During the focus groups, almost all facilitators reported that the majority of attendees at their table had not heard about the prior Strategic Plan. There were exceptions, however, and some facilitators reported that their group included a small number who were well-acquainted with the Plan. It is difficult to know with certainty which states or roles were more likely to be aware of the previous Plan, but there was evidence that those with greater awareness had responsibility for STEM policy at the state or national level.

> So, from my group I found that no one was familiar with the Plan and that no one had seen the Plan before. (Facilitator)
>
> I knew about the 2013–18 Strategic Plan through national initiatives, not through my state.
>
> I didn't know about the Plan until I was nominated to come to this Summit. I asked our local school district and learned some benefits.
>
> Anyone who was at my table who was in a state was not aware of the Plan. There were two people at my table who were not state people; they were working on a national level. One was from a funding agency and one was [from a national organization] or something broader. And only those two people knew about the Plan. Everybody else had no knowledge of it. (Facilitator)
>
> So, the person who used it an extensive amount in their state was a state science supervisor, a science specialist for the state, very aligned to the purpose of this work, and they used it extensively. Whereas the people in the other state . . . they really were doing their own thing, and they were kind of proud about that. (Facilitator)

Perceived utility of the previous Plan.[5] Given attendees' limited awareness of the prior Plan, there was little conversation about its perceived utility. In fact, there may be confusion about the purpose of the Federal Plan, including how it relates to state and local policies and its influence on federal and state funds.

> They think some things are federal, and they're actually state or local policies, and so they're not really familiar with what a federal STEM Plan can do because they think that it is Common Core, or they think it is something else when that's not federal. So I think there was this general lack of understanding, nobody ever really said, "Oh, well, I know that the funding goes this way or the program administration goes this way." All they know are things like, "Oh well, I have all these stipulations on this grant," or . . . but what they don't really know [is] how that all flows down from the federal level to the school level. (Facilitator)

Those who were aware of the Plan offered varied explanations for the nature and extent of its impact, and one facilitator reported that their table discussed the way it could have helped by providing some continuity in policy goals following turnover among state elected officials.

> And I did hear that although they weren't aware of the Federal Plan, given change at the state level—like, one state was getting a new governor—they did feel like the Federal Plan would help with continuity. So they did see the importance of it, even if they weren't aware of it. (Facilitator)

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5   For additional findings regarding the discussion of Question 1, see Appendix D.

> But [in] my group we had a gentleman . . . who was on the writing team for the first Plan. And so he quickly informed our table that the Plan wasn't written for the states, it was written to guide federal agencies. (Facilitator)
>
> The absence of federal "offer" coupled with the absence of state and local "demand" led to a largely ineffective or outright miss on national strategy.

A small number of attendees provided examples of how the prior Plan had at least some impact on their state, suggesting that the Plan served as a vehicle for providing overall policy direction—for example, it provided a framework to facilitate statewide conversations, influenced the state's STEM plan, or informed the development of programs or initiatives. Lack of infrastructure (including Internet access and businesses to partner with) was noted as a barrier to implementation by leaders from rural or remote areas.

> Only a few at our table knew about the 2013–2018 Plan. What really did the Plan accomplish? The Plan did not appear to be an end in itself but one of many inputs that brought a needed emphasis on STEM.
>
> [The] metrics were useful, [the old Plan was] good as leverage to get state stakeholder buy-in, [and] good as overall guidance.
>
> Two of the three states were quite familiar with it, and they found that the main value was that it gave them a framework for discussions that they hadn't had before. In fact, I wrote this down verbatim: "It put us all on the same vocabulary for the first time." So, they were very adamant that it was very important just for being able to facilitate statewide discussions. (Facilitator)
>
> So, at my table, [one team] identified a number of ways that the past Strategic Plan helped, or actually they could point to the Plan and say some of the programs or initiatives that were developed and the synergy that was generated across programs from [their state]. [Another] person also said there was also some direct correlation, but the problem is lack of infrastructure, lack of Internet access. So, they may have all this training and tools, but without the infrastructure they can't apply it or it doesn't really help. They also made the comment about the lack of businesses to go to. So the message about *let's partner with industry and business* was like, yeah, there are just not enough, and who's going to be interested in coming to a rural or sparsely populated area to invest heavily in a partnership? So, that was something to listen to. (Facilitator)

Two facilitators noted that although the majority of attendees at their tables were not familiar with the previous Plan prior to the Summit, they came to realize that their state plans aligned with the Federal Plan.

> Most people initially said that they were not specifically aware of the past Strategic Plan, eight out of nine. But by the end of the conversation, four of nine said that there were aspects of the Plan that aligned with either their state plan

> or—two of them said specifically that they could see the alignment with their applications to federal proposals. And when they recognized that, then the Plan did seem to take on more importance to them. (Facilitator)

However, other participants seemed less clear about whether the prior Plan had an influence in their state.

> But that said, they did see an increase in the importance of STEM in the state, but they weren't clear if that was a result of the Plan or not, or where the benefits originated from. Some states had STEM leadership councils that developed their own strategic plans. Whether or not those were mapped to the Federal Plan, they didn't know, so there was a complete lack of awareness of the Federal Plan. (Facilitator)

> Two [at my table said] they were benefiting from programs, but they had no idea that they were connected to the Plan, if they were. And the other had no idea that there was a Plan or an effort or anything. (Facilitator)

CONCLUDING THOUGHTS

Although few attendees knew about the prior Strategic Plan, their understanding of it grew throughout the day, as did their appreciation for the many ways in which it could support their work at the state level. Attendees provided varied suggestions for how the next Plan could be improved and the explicit role it could play in influencing STEM education policy and programs, as well as public perception of the importance of STEM learning.

DISCUSSION OF QUESTION 2

What are the emergent trends and priorities of the STEM Community, and how might they factor in to the prospective 2018–2023 Federal Five-Year STEM Education Strategic Plan?

The introduction to Question 2 emphasized that this was the central discussion of the Summit and will be essential for informing the priorities in the next plan; the goal was to understand the high-frequency priorities of the states and territories and to hear opinions on the list of goals for the new STEM Education Strategic Plan. Ninety minutes were allotted for this discussion: 5 minutes for introductions, 20 minutes for state teams to identify their top three Aspirations and their number-one priority, 20 minutes for state teams to share their lists and answer questions (see below), 30 minutes for whole-table discussion, and 15 minutes for reflection and synthesis.

All participants were provided with the following list of "10 STEM Aspirations" identified by Office of Science and Technology Policy leaders after listening sessions with individuals and groups from across the STEM stakeholder community in the months leading up to the Summit:

1. Expand partnerships of educational entities and employers through:

   1a. Work-based learning opportunities, including pre-apprenticeships, apprenticeships, internships, job shadows, job boards, cooperative education, and mentorships in STEM K–20

   1b. Partnerships that support re-skilling and upskilling of the under-employed, retirees, displaced workers, returning veterans, etc.

   1c. Expanding industry-recognized credentialing for STEM education programs

   1d. Offering Teachers-in-Workplace experiences

   1e. School+Workplace collaborations at the K–12, certification or credentialing, two-year, four-year, and graduate levels

2. Foster STEM ecosystems that unite all stakeholders across communities and states (employers, K–12, higher education, nonprofits, informals, local governments, etc.) to drive talent toward STEM careers, which will in turn support economic development, especially in the realm of building America's skilled technical workforce

3. Advance innovation and entrepreneurship education through a variety of approaches, such as business start-up incubators, prototyping and inventing (and reducing barriers to invention, such as patent fees), entrepreneurship development, making, and problem-finding

4. Promote the use of digital platforms for teaching and learning (research and programming) to bring the best (virtual) teaching into every classroom—this strategy has enormous potential to close the "educator quality chasm" that hampers high-need schools and communities (both urban and rural) in particular

5. Weave computational thinking principles[6] universally across grade levels and into all school subjects and nonformal and informal learning events (using, for example, data science as a computer science context across disciplines)

6. Promote digital literacy and fluency and cyber-safety practices—including information-gathering and communication, analysis of information, judicious communication, and critical analysis—by focusing on competency and demonstration via assessment versus rote recall

7. Increase diversity and inclusion of all Americans in STEM programs, including women, minorities, persons with disabilities, and people in rural areas, by, for example, focusing on retention at critical transitions, and addressing the Belief Gap[7]

8. Support the contextual integration of the mathematical sciences across grades and subjects through contemporary open questions, so that all students come to see mathematics as an engaging field, rich in beauty, with powerful applications to other subjects

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6   Computational thinking principles include organizing data for effective communication, generating algorithms for procedures that reliably analyze processes, using data and algorithms to create computational models that simulate complex systems, and comparing computational models to derive new insights.

7   The Belief Gap is the gap between what students *can* achieve and what others *believe* they can achieve.

9. Usher in a new era of transdisciplinary, or convergent, study across STEM (and beyond) in which teams of learners investigate broad questions reflective of modern societal challenges, and where teachers focus on learners' competency and demonstration via assessment rather than rote recall

10. Erase artificial boundaries between traditional college-preparatory and career technical education and between formal (school-based) and informal (out-of-school) STEM education in terms of impact assessment, practitioner credentialing, professional development, and public-private partnerships; align what is taught to what employers need

Following a process of individual state team-work and whole table discussions, each team considered the highest-priority STEM Aspirations, a rationale for why these and not others, and an offer to articulate any that were missing with an explanation for why they should be included.

RESULTS OF QUESTION 2 DISCUSSION

Several key findings emerged from the discussion of high-priority STEM Aspirations. These are presented below, followed by the detailed results of our analysis of the relationships between the Aspirations, and areas for improvement in STEM education that the Strategic Plan can address.

Key Findings

- Whether looking at individual states' rankings, table rankings, or facilitator reflections and focus group notes, there was consistency in individual attendee opinion regarding the four Aspirations that were considered to be of the highest priority:

    - **Aspiration 1:** Expand partnerships between educational entities and employers

    - **Aspiration 2:** Foster STEM ecosystems that unite all stakeholders across communities and states

    - **Aspiration 7:** Increase diversity and inclusion of all Americans in STEM programs

    - **Aspiration 10:** Erase artificial boundaries between different STEM education and career pathways

    It is notable that these four Aspirations highlight the need to reduce perceived fragmentation and isolated efforts in STEM education, and to promote greater cooperation, communication, inclusion, and integration of stakeholders and learners in order to drive real and lasting improvement.

- Attendees did not see the Aspirations as separate and distinct, but as inter-related and inter-dependent. Many groups suggested ways to combine and/or group them in order to reflect broader goals.

- Participants highlighted 11 features of the STEM education system that the next Strategic Plan should help states address. These features fell into three categories: STEM teaching, system capacity, and policy drivers. Increasing equity and diversity (a policy driver) and

providing teachers with needed supports (system capacity) were viewed by the majority of attendees as the two most critical areas for improvement, followed by starting students' STEM education early and improving assessment approaches (both system capacity).

Table 1 presents the final synthesis of endorsements for the top four STEM Aspirations by region, in order to more easily identify any meaningful regional patterns.[8,9]

Table 1. State votes for the top STEM education Aspirations by region and overall

	Region									
	Northeast		**Midwest**		**South**		**West**		**All States**	
	States in Region									
	9		12		19		15		55	
	Total Vote Count and % of Regional Votes									
Aspiration	**Total**	**%**	**Total**	**%**	**Total**	**%**	**Total**	**%**	**TOTAL**	**%**
1	7	78%	7	58%	13	68%	7	47%	34	62%
2	5	56%	9	75%	16	84%	6	40%	36	65%
7	6	67%	6	50%	9	47%	7	47%	28	51%
10	7	78%	9	75%	11	58%	8	53%	35	64%

As described in Appendix E, individuals at tables discussed and ranked the ten Aspirations differently, with some explicitly ranking their first, second, and third highest priority, and others identifying Aspirations more generally as of high importance or priority. Because individuals used different metrics and methods for ranking their highest priority Aspirations, the numeric totals in Table 1 provide a *general* indication of participants' priorities, rather than precise aggregate rankings based on a uniform scale. It is therefore difficult to state with confidence, for example, that based on data from participants' stickies and facilitator reflections, Aspiration 2 (identified by 36 states as a priority) ranked higher than Aspiration 10 (identified by 35 states as a priority). Instead, data from both the participants and facilitators, as summarized in Table 1, suggest that Aspirations 1, 2, 7, and 10 consistently and categorically were identified as higher in priority than the other Aspirations.

Relationships between the STEM Aspirations

The 10 Aspirations were often viewed as inter-related and inter-dependent rather than as discrete goals. Participants from 23 states discussed ways in which they overlap and could be combined. For example, Aspiration 7: *Increase diversity and inclusion* was regarded as a value underlying other Aspirations by some, whereas others saw it as a positive outcome: "If we get

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8   For ease of display and understanding, the jurisdictions are grouped by U.S. census region. The jurisdictions included in each region are provided in Table 7 in Appendix B.
9   For the final synthesis of votes for all 10 aspirations, see Table 8 in Appendix B.

#2 right, #7 will fall into place." Similarly, others viewed Aspiration 2: *Foster STEM ecosystems that unite all stakeholders* as a vehicle to get to the outcomes laid out in Aspiration 1: *Expand partnerships*.

Discussions of priorities prompted proposals for combining Aspirations, in part because of their inter-relatedness and also to achieve greater parsimony. For example, after much discussion, the table group comprising Idaho, Oregon, and Washington grouped nine of the Aspirations to create three new ones:

1. Increase access and opportunity (Aspiration #s 7, 1, 10, 4)

2. Increase capability and capacity (Aspiration #s 8, 5, 9)

3. Increase understanding and relevance (Aspiration #s 2, 3)

The members of that table also cautioned that any goals must be made meaningful and measurable in order to promote accountability.

One facilitator's comment represents a common approach and purpose that drove ideas about combining Aspirations:

> My group discussed that Number 2 and Number 10 could sort of be combined because it's all about alignment of ecosystems and getting people to work together. And that theme kept coming up, that we need alignment, we need people to work together.

Representatives from Nevada, California, and Arizona were at the same discussion table and did not prioritize the STEM Aspirations that were provided; instead, the representatives generated their own thematic priorities. However, throughout the discussion among the participants from these states, themes emerged that echoed features of the 14 Aspirations:

1. Workforce relevancy of STEM must be evident to students; to teachers; parents, caregivers, and families; and to communities

2. Efforts must be sustainable and scalable

3. Increase equity and access to high-quality STEM education in order to reach the untapped STEM workforce and build its capacity

4. States' voices must be heard

5. Funding should be based on state priorities and should include performance and accountability measures

In the analysis of endorsements for high-priority aspirations, 13 states and the District of Columbia suggested 19 different combinations of Aspirations that represented approaches to simplifying the schema and acknowledged their interdependencies. Table 2 shows the most frequently suggested combinations of aspirations. In addition to being seen as closely related to promoting digital literacy and supporting the integration of the mathematical sciences, computational thinking was merged with other in nine other combinations. Similarly, participants suggested that expanding partnerships and fostering STEM ecosystems could be merged with other Aspirations in eight different combinations.

Table 2. Most frequently suggested combinations of aspirations

# of States Endorsing	Combinations of Aspirations
4	Expand Partnerships (Aspiration #1) Foster STEM Ecosystems (Aspiration #2)
8	Expand Partnerships (Aspiration #1) Foster STEM Ecosystems (Aspiration #2) Plus combinations of other aspirations
5	Weave computational thinking across grade levels, subjects (Aspiration #5) Support integration of mathematical sciences (Aspiration # 8) Plus combinations of other aspirations
4	Weave computational thinking across grade levels, subjects (Aspiration #5) Promote digital literacy (Aspiration #6)

The considerations of the attendees demonstrates the deep thinking they had done about the Aspirations. As a result, they were able to articulate the relationships they saw between the Aspirations, and how they might be merged to bring greater coherence to the Plan as well as provide a clear and comprehensive set of priorities to the STEM education community.

Areas for Improvement

As participants discussed the 10 Aspirations for STEM education in their states, they also identified features of the current STEM education system that need to be changed or strengthened, and where efforts to do so could be positively influenced by the new Strategic Plan. These additional needs or areas for improvement fell into three categories: STEM Teaching, System Capacity, and Policy Drivers (see Table 3).

Table 3. Areas for improvement

STEM Teaching	System Capacity	Policy Drivers
• Greater Rigor • Integration within and beyond STEM disciplines • Relevance of STEM	• Assessment • Teacher Supports • Multiple Pathways • Prepare for Future Innovation • Early Start	• State and Local STEM Planning • Equity and Diversity • Sustainability and Scalability

These categories and themes are defined below, as drawn from the documentation of table conversations; illustrative quotes transcribed from the sticky notes and chart paper are also included. Because both facilitators and participants took notes, it is not possible to attribute the quotes we include to one role or the other.

Category 1: STEM teaching. The issues in this category relate to the features of STEM instruction, both within and beyond the classroom that all students should experience but that are currently not characteristic of STEM instruction.

Greater rigor. Participants believed that STEM courses (PK–20) need to be more rigorous, and the importance of math and computational thinking was stressed by many. Moreover, rigor was

defined in different ways: some referred to hands-on, inquiry-oriented pedagogy, others to setting high expectations for students, and still others referred to building critical-thinking and problem-solving skills to prepare students for a competitive world.

> Improving STEM ed in order to prepare students for post-sec pathways requires a systemic approach, including fostering a culture that values high-quality instruction and rigor in student learning for all students.
>
> Be clear on performance goals and Aspirations regarding critical thinking, problem-solving, creativity, and curiosity (math and science) to improve pipeline.
>
> The approach to teaching STEM (the teaching pedagogy) needs to be modernized to get away from sit-and-get [to] more hands-on, inquiry, and discovery-based for students in order to prepare them to solve the problems of tomorrow that aren't yet known.
>
> Focus on future fundamentals is important—computational thinking, entrepreneurial thinking, etc. Need to start earlier in the pipeline—preK onwards.

Integrate STEM. Many participants see a need to integrate the STEM disciplines with one another as well as to integrate STEM into other subjects. These participants shared the notion that STEM was at the heart of all learning.

> Create computer science exposure in math curriculum and not separate. Computer science is scary—math is less.
>
> Integrate STEM as core of education—STEM should not be separate from core learning in education. STEM is involved in every aspect of work— should also be in every aspect of learning.

Relevance of STEM to careers and lifelong learning. Participants discussed the need for STEM courses to focus not just on workforce development, but also on critical-thinking and other skills needed for a well-educated citizenry and lifelong learning. Business and education leaders viewed the potential outcomes of the priorities somewhat differently, with business leaders more often emphasizing career skills and work readiness, and educators emphasizing those outcomes as well as the importance of STEM to students' and adults' continuing education and lifelong learning.

> We must align economic opportunities with K–20 and integrated workforce development. It must not just be about current industry certifications and pathways, but about building critical thinking, problem solving, resilience, and adaptability in STEM education for the rapidly changing future, which is not realized now.
>
> Career-connected learning is critical for inspiring relevance in education, entrepreneurship, skill development, and systems thinking.

> Critical thinking and essential skills spelled out—on-the-job experiences and WBL [work-based learning] are critical to preparing for [the] workforce—technology changes, but critical thinking is always needed.
>
> **Key theme:** STEM [is] not only for workforce development but ALSO to provide students with problem-solving and critical-thinking skills AND appreciation for scientific thinking, etc.

Category 2: System capacity. The issues in this category encompass the features of a STEM education system that enable effective STEM teaching and strong student outcomes to occur, improve, and adapt to changing demands, opportunities, and learner needs.

Assessment. Participants called for authentic assessment of student STEM learning, and noted how critical assessments are for meaningful understanding of progress. Participants were clear that they were not advocating for more testing, but rather for more authentic assessment of student learning in a new STEM environment.

> The Plan should call on states to have plans for math and science performance. Not old-fashioned rote, but deep learning. That seems core…
>
> Key to continuity will be the badging and credentialing for skills. Fear is creating another set of high-stakes/high-priced tests.
>
> Change the conversation in America from high-stakes assessment to high-stakes innovation (develop flexibility to allow and encourage states to build accountability and funding around this).
>
> Authentic assessment at all levels—not just students, but teachers too.

Teacher supports. Participants recognized that teachers need ongoing professional development, resources, and support if they are to change the way they teach. Attending to challenges that the profession faces as a whole was seen as critical, including addressing the teacher shortage, increasing retention, and providing incentives to remain in the profession and strengthen teaching. Suggestions included creating in-service and pre-service opportunities, orienting teachers to industry needs and skills, and supporting them in learning how to teach STEM as a whole as compared to a single STEM discipline.

> Address equity and access by building capacity—start early, elementary/middle—(1) recruit, prepare, and retain qualified STEM teachers; (2) [offer] PD for elementary-grade teachers PK–3.
>
> Teacher preparation programs that include career exposure that is related to their majors and teaching.
>
> Retrain teachers how to teach STEM—empowering STEM model.
>
> Focus not just on recruitment of STEM teachers, focus on RETENTION of high-quality STEM teachers.

Multiple pathways. STEM education programs and policies need to ensure that students have many different ways to prepare for and enter the STEM workforce, not just a four-year college degree. These preparation approaches could include work-based learning experiences and efforts to increase awareness of career options and education pathways on the part of students, families, educators, and career guidance professionals.

> Definition of STEM careers and academic goals must embrace trade, certificate, tech, and community college degrees.
>
> There needs to be a more broad understanding of post-secondary success—that is, college isn't necessarily more of a success than technical or trade schools.
>
> Integrate STEM initiatives focused on K–12. CCC [Certified Career Counselor] workforce credentials and STEM four-year degrees—current efforts are siloed.

Prepare for future innovation. These discussions referenced the need for education systems to be oriented toward innovation—to be nimble enough, willing, and able to meet changing needs and take advantage of new opportunities as they emerge.

> Based on the group discussions, it is important to reflect broadly on what economic (or other) opportunities exist that can influence the education on STEM.
>
> Guard against meeting current needs with any reformations. Go to future needs.
>
> Flexibility—schools need the ability to be flexible and [have] permission to take risks in order to promote innovation.

Early start. The emphasis on secondary and higher education was a concern for many. The importance of exposing students early to high-quality STEM education was raised, along with the observation that accountability for mathematics and English language arts (ELA) has eclipsed science in elementary school classrooms. This was an area in which both business and education leaders expressed interest.

> Engage young students early, in preK–6, with STEM careers.
>
> If we want students to have a STEM identity, we have to start early.
>
> STEM ecosystems are a vehicle for catching all students early, connecting Aspiration 2 to Aspiration 7.
>
> Whether it is workforce (business), educators, etc., we all see the same need to create a culture where STEM education is a priority starting in preK. STEM needs to begin in preK–12; waiting for college is too late.

Category 3: Policy drivers. These large, over-arching issues should motivate policymakers to act, influence, and/or enable the steps that must be taken to strengthen STEM education.

State and local STEM planning. Participants recognized the need for states, territories, and/or local districts to develop their own STEM plans for many reasons, including flexibility, given that

states have different capacities, resources, and levels of the infrastructure needed to promote and strengthen STEM education.

> Ecosystem—identify keystones to anchor initiatives and embed (empower) local realization.
>
> States can/should create their own strategic plan for STEM ed.
>
> Need for local, state, and federal FLEXIBILITY in approaches to drive talent.

Moreover, if the new STEM Education Strategic Plan is to be relevant and useful to states, it should be conceived and designed explicitly to support states' efforts to design, implement, and sustain strong STEM education programs and policies.

Equity and diversity. Diversity and inclusion in STEM programs is a critical factor in building a robust economy and in filling future STEM jobs. The commitment to and need for equity and diversity is profound, and this theme ran throughout each discussion; it was seen as a business need, a social need, and an obligation. In relation to Aspiration 7: *Increase diversity and inclusion of all Americans in STEM programs*, participants were keen to point out that diversity and equity are values that undergird all the other aspirations. Moreover, in order to expand engagement in STEM to all students, teaching strategies need to be appropriate for a variety of learners and learning needs.

In discussing Aspiration 10: *Erase artificial boundaries between different STEM education and career pathways*, the disparities between the college-bound and career and technical education tracks were highlighted. This goal was of great interest to participants because it sought to break down the stigma of trade and technical education and to equalize the prestige and emphasis given to college, trade, and technical education.

> Insular areas have a great need for support, especially if we are being asked to integrate and implement the federal STEM Plan.
>
> Equity of access needs to be embedded in EVERY initiative and needs to be addressed on a long-term sustainable basis.
>
> There is a significant need to develop a strategy to unite all stakeholders around STEM partnerships to include a key focus on inclusion, in particular within our immigrant workforce and with women of color.

Sustainability and scalability. Many participants see a need for long-term, scalable, and sustainable STEM programs and education infrastructure, recognizing the fact that one-off approaches will not solve the large-scale, enduring challenges of STEM education.

> Move away from one-off pilot programs to sustainable initiatives that are part of and integrated into core curriculum.
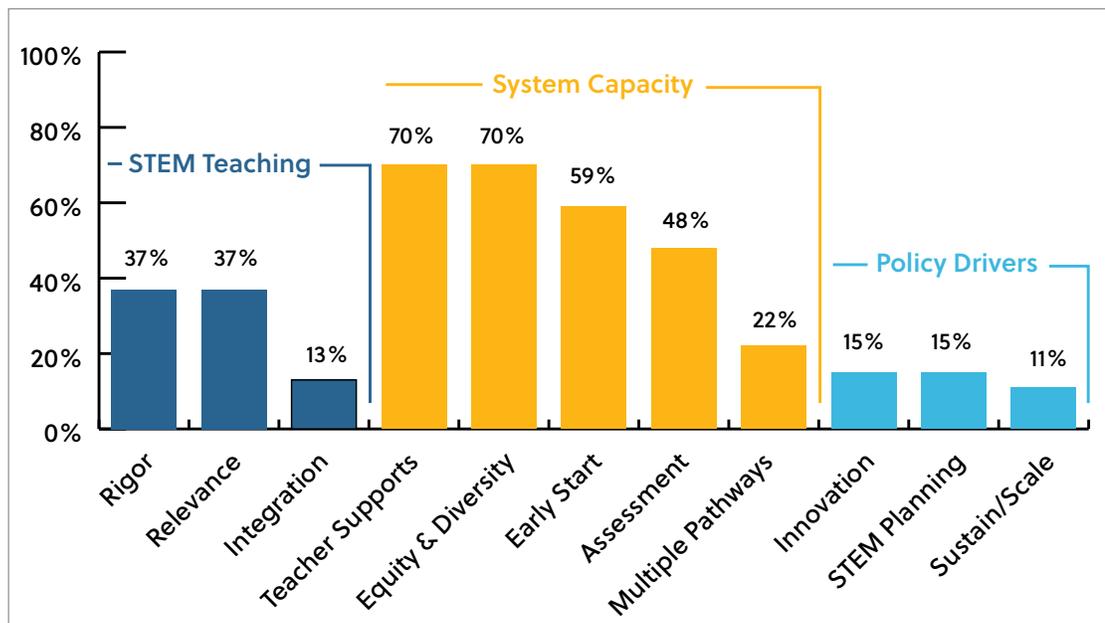>
> Equity of access needs to be embedded in EVERY initiative and needs to be addressed on a long-term sustainable basis.

> Digital platforms are an essential element to achieve our STEM Aspirations.
> Resilient and sustainable infrastructure is needed to support the digital platform.

Differences across states. These areas for improvement were discussed by multiple states, and the definitions above characterize the ways in which they were considered. However, not all issues were a topic of discussion among all state teams. The percentages of states that discussed each area are shown in Figure 1.

Figure 1. Percent of states that cited specific areas for improvement

Source: Stickies from Question 2 table discussions

Figure 1 shows the four most commonly cited areas for improvement that the Strategic Plan could help to address: Teacher Supports, Equity & Diversity (both cited by 70% of the states), Early Start (cited by almost 60% of the states) and Assessment (cited by almost 50%). These four areas present the Strategic Plan with clear targets for policy guidance, resource allocation, and advocacy.

Concluding thoughts

Summit participants engaged in the discussion about the Aspirations with energy and commitment. They took seriously the charge to identify the top STEM priorities that the Plan should address, and in addition highlighted existing areas for improvement that will impact states' ability to realize the Aspirations they identified. Taken together, the four high priority Aspirations and the four areas for improvement offer the authors of the Strategic Plan clear guidance from the field regarding how the Plan should be oriented if it is to advance the capacities of states to improve STEM education.

DISCUSSION OF QUESTION 3

What is the federal role and responsibility in supporting States' STEM education programs and policies?

The purpose of this discussion was to gather participants' views about the federal government's role and responsibility in helping regions succeed in strengthening STEM education. In particular, what, beyond money, should the Federal Government do to help their STEM efforts? Participants were encouraged to think broadly—beyond funding. For example, should the government do research on the STEM condition to inform state policies, create new federal policies that would support their state's STEM efforts, or use the federal megaphone to help make the STEM imperative more prominent, or would less intrusiveness by the federal government be more useful? Sixty minutes were allotted for this discussion: 5 minutes for introductions, 45 minutes to discuss Question 3, and 10 minutes for reflection and synthesis.

RESULTS OF QUESTION 3 DISCUSSION

The issue of what did not work well for the prior Plan, and what role the federal government could play in increasing its effectiveness and impact were discussed by participants throughout the day. Below we present the key findings that emerged from all three discussions on this topic, followed by a detailed description of the themes and illustrative quotes drawn from the data. In addition to referring to the participants' comments, we also refer to the facilitators' reflections because they shed an interpretive light on these ideas.

Key Findings

The key findings for this discussion relate to five action areas where systemic change is needed for successful implementation of STEM education policies and programs, and where the federal government has an opportunity and obligation to lead. These action areas are:

1. Promote and prioritize STEM

2. Increase access to and the flexibility of resources

3. Align resources and the Strategic Plan to measurable goals

4. Increase engagement and collaboration among STEM stakeholders

5. Address the tension between flexibility and uniformity of the Strategic Plan

Participants' views of the federal role with regard to each of these action areas are summarized below, followed by a detailed description of what participants believe the federal government can do to have a positive influence.

- **Promote and prioritize STEM.** Participants agreed that our society—parents, educators, elected officials, education policymakers, and the business community—needs a better understanding of the value of STEM learning for students' future careers, adults' active citizenship, and our country's economic development. Participants called for a "culture change" whereby all stakeholders would value STEM and STEM education, and thereby

support the systems and safeguard the resources needed to provide high quality STEM education to all. The federal government has a critical role to play in advocating for STEM and unequivocally reinforcing the message of its importance and relevance to citizens' own lives and to our country's collective future.

- **Increase access to and the flexibility of resources.** There are a variety of sources of federal support for STEM programs but they can be very difficult to navigate and unresponsive to states' needs. Participants noted that the landscape of federal agencies' funding programs is incoherent overall, and programs that should be well coordinated are occasionally in conflict with one another. Participants called on the federal government to provide greater coordination, flexibility, and transparency in federal agencies' STEM funding.

- **Align resources and the Strategic Plan to measurable goals.** The Strategic Plan must be driven by a strong, clear vision for STEM education that is made concrete and actionable by a clear theory of action, a measurement and accountability function, and aligned with funding opportunities and systems. The federal government has a responsibility to define these national STEM goals, and provide resources and infrastructure that states will need to be successful.

- **Increase engagement and collaboration among STEM stakeholders.** The relevance of STEM education to a wide and varied group of stakeholders is notable, and the different perspectives they each bring to discussions of how to improve STEM education were seen as a strength. At the same time, participants observed that not all stakeholders are represented in policy discussions, and that stakeholder groups are not necessarily familiar with each other's needs or perspectives. The federal government has a leading role to play in ensuring that all stakeholder groups become and remain engaged in policy discussions and decision-making regarding STEM education. Greater communication and collaboration can extend to include federal and state agencies, as well.

- **Address the tension between flexibility and uniformity of the Strategic Plan.** Participants had mixed views about how flexible the Strategic Plan should be versus how uniformly it should be followed. Some participants described flexibility as allowing states to select from a "menu" of possible activities, programs, and policies. This approach would enable the Plan to be responsive to states' unique needs and conditions. At the same time, participants were concerned that it would also allow states to opt out of addressing high priority challenges, in particular, increasing equity and diversity. The federal government should be aware of this tension between flexibility and uniformity and seek an appropriate balance between them.

Detailed description of action areas and the federal role

Action Area 1. Promote and prioritize STEM. The observation was made many times that students; parents, caregivers, and families; teachers; and communities at large need a better appreciation for and understanding of the value of STEM learning for students' futures. Participants repeatedly called for a "culture change" to counteract the competing pressures

for school time and resources that overshadow STEM learning, with a new focus on "increasing student aspirations in STEM and on providing rigorous, challenging opportunities for students and the educators who teach them."

> How can we support/encourage schools, families, and communities to champion STEM for all students? If it is important, it needs to be messaged that way.
>
> STEM is being put to the side so teachers can teach to standardized testing due to pressure from schools and districts in K–12.
>
> Accountability in ELA and math has forced science and STEM out of our elementary school classrooms.

In response, participants called for greater advocacy for STEM, and the need for the Federal Government to create a "STEM narrative" in order to increase awareness about the need for STEM. Some referenced prioritizing STEM, others referred to promotional or public relations efforts. In addition, some participants linked these promotional efforts to student learning and others to the potential success of the new strategic plan.

> Next Plan should include strategy/ideas for increasing broader appreciation of science and engineering so learners enhance critical-thinking skills applicable in any future career (not just STEM).
>
> K–12 emphasis on science needs to be measured and on a more equal footing with math and literacy, especially in the elementary grades.
>
> Need support from federal government about how STEM is not a side thing but a part of everything. There is not a "STEM room" or STEM aside from everything else—it's a part of all education.
>
> We need to engage every generation of those being affected by lack of STEM focus—young people, children, young teachers, and then also older people like most of us in this room.
>
> They weren't familiar with the Plan at all so we couldn't really discuss it in any detail, but they were really concerned that the next plan is marketed bottom up and top down as well so that there's a comprehensive understanding of what it means and what it's supposed to do. (Facilitator)
>
> Next plan should include strategy/ideas for increasing broader appreciation of science and engineering so learners enhance critical thinking skills applicable in any future career (not just STEM)

A federal role in the advocacy for STEM could include a variety of actions. For example, evaluating and identifying successful programs, sharing successful models, and providing best practices with regard to classroom instruction, teacher training and STEM programs. Some participants distinguished between making recommendations regarding the use of best practices rather than mandates.

> Feds can help with the "institutionalization" of successful STEM program by creating a program to develop ideas on how to do it. School districts and university admin need to learn how to continue successful programs beyond the durations of their grant.
>
> Enormous resources have been spent at NSF to generate innovative teaching ideas. Federal government can support scaling those ideas so they can impact more students
>
> Need of exemplars as models for elementary teachers on how to "do" STEM in the classroom
>
> Best practices on networking database
>
> Landscape analysis to extract common elements for success
>
> National campaign like "got milk" but "got STEM?" to reach parents and students, to encourage retirees to teach.
>
> Feds can use national soap box/bull-horn to bring attention to STEM especially considering how few know of 2013 plan
>
> Need support from federal government about how STEM is not a side thing but a part of everything. There is not a STEM room or STEM aside from everything else—it's a part of all education.
>
> We need to engage every generation of those being affected by lack of STEM focus - young people, children, young teachers and then also older people like most of us in this room.

Action Area 2. Increase Access to and Availability of Resources. Participants discussed the need to improve awareness of and access to resources, particularly funding and infrastructure. Many participants are not aware of the funding opportunities available to them (some believed an online portal could streamline access to these resources), while others viewed current federal grants as too competitive and restrictive with regard to acceptable or required uses of funds by grantees. For example, the requirement that a school or state must work with a university was seen as overly prescriptive.

Moreover, the abundance of education policies and regulations, some of which are outdated and/or ineffective, create an environment that is difficult to navigate. Business leaders called for federal grants to "be available in a coordinated fashion such that different schools and/ or educators and workforce leaders can work together regardless of the funding agency." This becomes relevant when considering STEM ecosystems, which, by design, knit together varied stakeholder groups without common knowledge bases regarding federal supports. For ecosystems to succeed, "organization is vital," as is infrastructure at the state level.

Some participants referenced the needs of specific stakeholders, such as rural areas' frequent need for improved broadband access in many communities, while others referenced the

overall variation in resource needs depending on the state, and the need for flexibility to meet these varied needs. Finally, participants called on the Federal Government to reform funding mechanisms and/or provide a means of sharing information about funding opportunities and educational resources.

> I believe that we need to focus on the interrelationships among and between agencies (federal and local) in helping to identify areas, including future, to focus on in developing the workforce pipeline and education.
>
> Federal grants/money needs to be available in a coordinated fashion such that different sectors (ed/workforce) can work together regardless of the funding agency. Too much time spent looking at all the funding agencies—make it more straightforward.
>
> Lack of support for facilities and technology infrastructure that ensures universal access for all students (esp. rural)
>
> Provide funding for infrastructure – ink broadband – to enable collaboration in states and between states
>
> To be more inclusive and reduce inequities, we need to ensure that if a STEM grant needs infrastructure that those needs are included as part of the STEM grant.
>
> We need state-level leadership infrastructure models and incentives (could be federal) to adopt best models to advance STEM in each state
>
> Fed STEM policies and priorities without resources won't create meaningful progress
>
> The message that I got from my group was that funding plus guidance equals action. So if they don't know anything about guidance, or if they don't know what the mission is, they don't get funding to implement or make any changes, then there's not going to be change at the state level, no action. (Facilitator)
>
> Equity for states in grant funding because in the past, the states that needed it the most were often left behind
>
> Move from a competitive to formula STEM fund to ensure sustainability
>
> Distributing resources equitably: competitive resources go to highest scorers. Higher resourced schools have the time, experience, to write more competitive applications for resources.
>
> Federal government could try to "model" coherent STEM policy and programs and funding that moves states to adopt same.
>
> Marry resources (DoL and DoEd)

There should be more integration among different sectors, and better coordination with other federal policies.

And I think what they were asking for is can you please try and have a more comprehensive approach where No Child Left Behind really hurt STEM and that was very clear. And then Race To The Top hurt in some places and helped in others. ...I think that they're looking for policies also need to be part of this plan [and] how you execute what's going to make it easier for states and people... over the coming period of time. (Facilitator)

Is there a way to create "grant pathways" across agencies? Not sure. Thinking if you are awarded a NASA award to provide programming to a certain subset of student, could you draw a line to a logical next step grant from the NSF, for example, to study the impact of the program on students learning?

Create neighborhood/state STEM hubs that are incentivized by NSF

Do not tie fed funding to state adoption of national standards

Provide mini-innovation grants, <100K, to run experiments to learn about the needs of communities which can be won by NGOs, small business, and other minorities. Small orgs can't win against universities which are black boxes (or worst, black holes)

Better communication including fed programs in states, (break down geographic and political silos) and [enable entities] to leverage opportunities from other states/orgs/fed

Reduce competitive grants at federal level. Make them sustainable, formula-based, easy to apply for

Raise awareness of available resources

Action Area 3. Align the Strategic Plan to measurable goals. Participants wanted to see a clear through-line for the Strategic Plan that began with establishing and communicating a clear vision and theory of action for STEM education, creating mechanisms to ensure on-going buy-in for the Plan (this could be through partnerships and increased communication between the federal agencies and states), strategic implementation of the Plan, and the timeframe, resources, and infrastructure needed to monitor implementation and evaluate progress—all for the purpose of maximizing the Strategic Plan's sustainability. The federal role extends beyond the framing of the Strategic Plan to continuing to engage the broader STEM community in its implementation, review of its impact, and consideration of adaptations to ensure the work progresses.

Actually include the people doing the job (elementary, junior high, etc.) in writing the Plan

How will you engage us again as a follow up to this work? How can we ensure this does not stop here?

> Need a plan that starts w/strong vision, accountability function, program funding
>
> Set up grand vision: Fund collaboration across industry/ed/funding; Who scales effective practice? Who develops effective STEM practice? Outcomes research; We need theory of change!
>
> Feds should define the big national STEM goal, what the feds will do to support reaching the goal. States should follow suit with their own plans and how long they will [take to] meet their goals
>
> Consider how programs, accountability, and funding intersect to support states/regions.
>
> The strategic plan needs to be measurable with explicit details on how this would be supported
>
> 3-year or 5-year experiments in education are insufficient.
>
> Those who were very workforce focused saw this plan as very airy and abstract and aloof and non-measurable. Like it was more aspirational than impactful. They… would pick it up and throw it because they're like, I can't use that. You can't measure that. How are you going to make that impact? They were very critical….Like if you're focusing on education, STEM education for workforce, that plan really rubs you the wrong way. But if you're focused more on citizens and community members they may, I'm inferring here… they may have liked it more. And that's just different people are focusing on STEM for different reasons. (Facilitator)

Action Area 4. Increase engagement and collaboration among stakeholders. The Summit brought together leaders from the education, business, and policy sectors, and their different perspectives, areas of expertise and experience were apparent. For example, although all were united by a commitment to STEM education, the observation was made that a common definition of STEM was missing. Moreover, although bringing different points of view to the mission of improving STEM education was seen as a positive, it was also acknowledged that limited understanding of each other's needs, capacities, and challenges hindered communication and sometimes slowed progress. Many participants cited their lack of knowledge of the previous Strategic Plan as evidence of the need to improve communication and collaboration. Moreover, they saw a need to discuss not only strategic plans, but also existing funding opportunities and resources. The need and desire to improve collaboration and communication between stakeholder groups extended to include cross-agency collaboration and between agencies and states.

> Industry representatives said involving business is critical—and not the "usual suspects" in industry who are already involved in educational outreach initiatives.
>
> Everyone said the industry should be more involved in a new plan because it wasn't very apparent of their involvement with the old plan. But that being said

I didn't get very much industry input... but they did say because, they are pretty much going to do what they want to do and they're not going to be led by or directed by the federal government to get involved to a certain extent. So they didn't want it to be a mandate or a directive to get involved, but they would like to be more included. So they were happy to hear that Labor and Commerce are now part of the FC STEM group and will be contributing to it because they felt that was absent in the last one. (Facilitator)

State officials don't understand federal role

That's what somebody said in our last group, that everybody comes to the 20% of industry partners that they know of and that are out there and where is the other 80% and how to get them involved? (Facilitator)

My group kept saying that there was a missing piece, but they could not... they really couldn't define what was missing. But I felt like, from all of their discussion, that it went back to the integration that we talked about versus collaboration. That there needs to be much more integration across region, states, business, education. It just kept coming up. Breaking down the silos and having integration. (Facilitator)

Business and K-12 need to come together to understand the needs of both entities. The lack of understanding between the two creates a wedge. Externships for teachers and for business into education.

Need consistency across US about a STEM definition

We tend to have provider mindsets—need to focus on the user perspective— industry, students, etc.

Participants identified strategies such as incentivizing collaboration through grant requirements and funding a mechanism that would bring together industry, educators and policy makers on a state level. Some supported the creation of new communication mechanisms across agencies, industries and geographic areas.

Collaboration among sectors is imperative to break down barriers and work synergistically on behalf of students K-12

Have dollars available as incentives for business and industry to work with school systems to implement STEM. Helps create collaboration and promotes getting results.

Think differently about partnerships, especially in rural areas and continued efforts for exposure

Take vision of CoSTEM to state level and align federal and state levels. Make sure all players are at the table.

Need for more employer engagement and more synergies between K-12 and post-secondary education, including registered apprenticeships and vocational/ technical/education

Really important to have fed help create communication with localities, understand what is federal regulation vs. local regulation

Putting incentives for creation of state STEM goals and create state STEM leadership to create an infrastructure for communication

Build collaboration between state officials, agencies and teachers

Better communication including federal programs in states (break down geographic and political silos)

Money sent to collaborative groups

Action Area 5. Address the tension between flexibility and uniformity of the Strategic Plan. In the debrief focus groups immediately after the Summit, facilitators noticed a tension that was expressed at their tables about how prescriptive versus flexible the Plan should be: enough flexibility to allow states to customize but enough specificity to result in measurable change. Participants' different perspectives on this question suggest the different interests, capacities, conditions, and contexts of states across the country.

And one of the things that people said very clearly was that we should have flexibility. There should be flexibility for people to pursue different things, for people to be innovative. But at the same time, there was sort of this tension because people were saying we do want direction. (Facilitator)

So they're saying that... instead of one line that says, "Build better underrepresented strategies" every one of these [aspirations] should be approached with underrepresented [in mind]. I can't tell you how many times these people kept saying, "We need more diversity. We're left out. We need more diversity. We're left out." So they want to see in a new plan something that's a more holistic approach and not a menu type of thing [where] people can choose [particular strategies] because they don't care about diversity. (Facilitator)

We heard the opposite, which was we would want the Plan to be viewed as a menu. Specifically that was the word that was used. Viewed as a menu where we can choose which [strategies] to [implement], that it's not an all or nothing. It's what can we do in our state because these are important for our state. (Facilitator)

Block funding for STEM w/flexibility to use for state needs

Local implementation, but a national vision. There was some head-banging around what an interesting person was saying, "The president wants to focus on STEM because there is value at the end of that which is employability. You work backwards through the value chain." And then another gentleman was saying,

> "No it's not linear, there's an ecosystem, there's no wrong door." And then the inner city guy said, "The no wrong door is a one size fits all approach and some doors and pathways need to be locked and there's dead ends." So there was a little bit of conflict about an ecosystem approach versus a top-down [approach], but that was the only conflict I saw in the whole day. Most people were on the same page. (Facilitator)
>
> Workforce development (WOJA) funds we need more flexibility to be able to use these funds to retrain (train in STEM areas) our unemployed workforce.
>
> Multiple or a variety of stakeholders who are allowed to apply for grant money

This tension will not be resolved once the Strategic Plan is written, but will continue to influence how states react to and implement the STEM education programs and policies the Plan will promote. The federal government has a role to play in mediating those tensions so that the spirit of the Strategic Plan is advanced, and STEM teaching and learning continues to be promoted, supported, and strengthened in states, communities, and schools across the country.

Concluding Observations

Four observations emerged from the process of reviewing the data gathered from the Summit's conversations and recalling the experience of the Summit itself. These observations offer a context for considering the material contained in this report:

- Across individual states' rankings, table notes, and facilitator reflections and focus group notes, there was consistency in opinion regarding the four Aspirations that were considered to be of the highest priority. Similarly, participants identified four areas for improvement that will need to be addressed if the STEM Aspirations highlighted in the Plan are to be realized. Attendees did not see the Aspirations as separate and distinct, but as inter-related and inter-dependent.

- The energy and commitment among STEM Summit participants was very high, and the interest in sustaining this level of engagement and input was clear. Participants seemed to share the feeling that they were involved in an effort that could have real impact, and that they were part of a process that has the potential for making a real difference for STEM education. This is all the more remarkable considering that many were unaware of the prior Strategic Plan and were engaging in high level policy discussions for the first time. There is an opportunity now to continue to engage these state STEM leaders and to build on the energy and commitment that they so generously invested in the Summit. Indeed, there will likely be some disappointment if no attempt is made to continue their involvement.

- There is a clear role for federal involvement in advancing the purpose of the Strategic Plan through acknowledging and addressing the five action areas that participants highlighted. These challenges are enduring and require a concerted effort to influence.

The federal government has an opportunity and the reach to make a difference, and Summit participants were clear about the importance of doing so.

- The conversations were constructive and productive, though participants brought to their table groups different perspectives, vocabulary, definitions of STEM, and other key concepts. One participant's note captured the need to address these differences if the potential power of the STEM Education Strategic Plan is to be realized: "The Plan can't be coherent if we aren't working from the same set of fundamentals."

APPENDIX A
Discussion process

Group discussions were held at small tables; each discussion was facilitated by high-level leaders from member agencies of the Committee on Science, Technology, Engineering, and Mathematics Education. Discussion groups comprised state, territory, and tribal community teams grouped regionally for Discussion 2 and across regions for Discussions 1 and 3. Eighteen facilitators led Discussions 1 and 2 with a total of 176 representatives participated at 18 separate tables, while 36 facilitators led Discussion 3, in which the STEM leaders were joined by 147 winners of the Presidential Award for Excellence in Mathematics and Science Teaching and Mentorship, convened simultaneously for this purpose.

During the week prior to the event, facilitators participated in one of two orientation sessions provided by the EDC research team, and then gathered again in the hour immediately preceding the meeting in order for EDC leaders to prepare facilitators for their role and to ensure that they facilitated their discussion groups as consistently as possible.

The purpose of each discussion and the process that facilitators would follow at their tables was introduced to the participants by Abigail Jurist Levy, Education Development Center, Inc. (EDC), ensuring that all table groups received the same directions to guide their conversations. Facilitators followed a Discussion Group Facilitator Guide prepared by the research team from EDC, which provided a set of focused questions, probes unique to each question, and a process for participants and facilitators to document the content of each discussion. (A copy of the guide is provided in Appendix C.)

Because the content of these discussions is the key outcome of the Summit, several procedures were implemented to capture participants' contributions:

1. Participants recorded their contributions on stickies, which were color-coded according to participants' leadership roles, and adhered them to sheets of chart paper. At the end of each discussion, participants were also asked to record their key takeaways on stickies and to post them on the chart paper.

2. Facilitators recorded the main points of each discussion, themes, and topics, in-taking the viewpoints of individuals around the table.

3. To provide a summary of each discussion, facilitators completed a reflection form in the final minutes of each discussion. Forms were provided in hard copy and online, and asked facilitators to describe the main points that emerged from the discussion, any trends or themes they noted among the participants, whether there was general agreement or disagreement, and whether they noticed any similarities or differences by participant role (i.e., education, policy, or business).

4. EDC research team members observed discussion groups and took field notes throughout the day.

5. Immediately after the Summit, facilitators participated in one of three concurrent focus groups, led by EDC research team members, to debrief their observations of the day's discussions.

6. Following the Summit, the EDC research team collected the chart paper with stickies and facilitators' notes, facilitators' reflections, and documentation from the focus group discussions and assembled them by discussion question. This material was used to inform our analyses.

APPENDIX B
Additional Information on Summit Attendees and Ranking of Aspirations

Tables 5 and 6 below display information about the Summit attendees, who represented the 50 states, the District of Columbia, Puerto Rico, the U.S. Virgin Islands, Guam, the Northern Mariana Islands, and several tribal territories. We relied on participants identifying their state when they documented their views on the stickies that we used for our analysis. The vast majority of participants did so consistently, but occasionally participants did not. When we report findings by state, such as we have in Figure 1., *Percent of states that cited specific areas for improvement,* we only report data that was identified with a state, therefore some states are not represented in some conclusions.

Table 5. Summit attendees by region

Region	# of Attendees	% of Attendees
Northeast (9 states)	22	13%
Midwest (12 states)	41	23%
South (19 states)	66	38%
West (15 states)	47	27%
TOTAL	**176**	**100%**

Table 6. Summit attendees by STEM leadership role

STEM Leadership Role	# of Attendees	% of Attendees
Business/Industry	25	14%
K-12 education provider	10	6%
Higher education	19	11%
State/federal education agency	43	24%
State/federal workforce development agency	33	19%
State/federal STEM CTE, education, workforce development	5	3%
Other state/federal government agency	3	2%
Elected state/federal legislator	5	3%
Informal education organization	1	1%
Non-profit education organization	14	8%
Non-profit workforce development organization	2	1%
STEM association leader	13	7%
Other	3	2%
TOTAL	**176**	**100%**

Table 7. States grouped by U.S. Census Region

Northeast (9)	Midwest (12)	South (19)	West (15)
Connecticut Maine Massachusetts New Hampshire New Jersey New York Pennsylvania Rhode Island Vermont	Illinois Indiana Iowa Kansas Michigan Minnesota Missouri Nebraska North Dakota Ohio South Dakota Wisconsin	Alabama Arkansas Delaware Florida Georgia Kentucky Louisiana Maryland Mississippi North Carolina Oklahoma Puerto Rico South Carolina Tennessee Texas U.S. Virgin Islands Virginia Washington, D.C. West Virginia	Alaska Arizona California Colorado Guam Hawaii Idaho Montana Nevada New Mexico Northern Mariana Islands Oregon Utah Washington State Wyoming

Table 8. State votes for the top STEM education Aspirations by region and overall

	Region									
	Northeast		Midwest		South		West		All States	
	States in Region									
	9		12		19		15		55	
	Total Vote Count and % of Regional Votes									
Aspiration	Total	%	Total	%	Total	%	Total	%	TOTAL	%
1	7	78%	7	58%	13	68%	7	47%	34	62%
1a	0		1	08%	2	11%			5	9%
1b	0		0		1	5%			1	2%
1c	0		1	08%	1	5%			2	4%
1d	0		0		0				0	
1e	0		0		0				0	
2	5	56%	9	75%	16	84%	6	40%	36	65%
3	1	11%	2	17%	4	21%	2	13%	9	16%
4	1	11%	2	17%	9	47%	3	20%	15	27%
5	3	33%	4	33%	6	32%	6	40%	19	35%
6	0		3	25%	5	26%	4	27%	12	22%
7	6	67%	6	50%	9	47%	7	47%	28	51%

	Region				
	Northeast	**Midwest**	**South**	**West**	**All States**
	States in Region				
	9	12	19	15	55
	Total Vote Count and % of Regional Votes				
8	3 33%	4 33%	4 21%	2 13%	13 24%
9	2 22%	3 25%	3 16%	2 13%	13 18%
10	7 78%	9 75%	11 58%	8 53%	35 64%

APPENDIX C
Discussion Group Facilitator Guide

Thank you for agreeing to facilitate a State-Federal STEM Summit discussion group on Tuesday, June 26. The overall goal of the Summit is to gather the perspectives from leaders across all 50 U.S. states, territories, and tribal communities to inform the direction of the next Five-Year Federal STEM Education Strategic Plan that will serve as a true "north star" for the nation in guiding STEM education policy. The White House Office of Science and Technology Policy (OSTP) is leading the writing of this Plan and has brought together more than 175 leaders in STEM education, policy, and business and industry to inform the development of this document. Toward the end of the day, we will also be joined by recipients of the Presidential Awards for Excellence in Mathematics and Science Teaching.

OSTP has asked for input on three main discussion questions, and will use this information to inform the development of the next Strategic Plan. Your role as a facilitator of these discussions is extremely important. Your responsibility is to open up each discussion with the participants assigned to your table, guide their conversation with the suggested prompts, and encourage participants to contribute as much of their best thinking, ideas, and experience as possible. You are not responsible for giving them information or correcting their misunderstandings, but rather for transferring the content of the discussions as accurately as possible to the EDC team.

EDC will rely heavily on the participants taking responsibility for recording their big ideas and take-aways from these discussions, on your own reflections throughout the day, and on your contributions during the facilitator debriefing with EDC staff at 3:30. These strategies are discussed in more detail in the *Facilitation Guidelines* section on p. 3.

If you have questions, contact Abigail Jurist Levy (alevy@edc.org).

SUMMIT LOGISTICS

Before the Summit:

- Please review the 2013 STEM Strategic Plan and this Facilitator Guide, which includes background information and prompts for each of the three discussion questions, an overview of what we want to learn from each discussion (this will help you prepare for the debrief), and a timing plan for each discussion.

- An invitation to the Summit's mobile app will be sent to you. All the material and information for participants can be accessed here (e.g., Summit agenda, venue information, participant list).

On the day of the Summit:

- Please bring your laptop. Other materials will be provided for you (see below).

- We will meet at the registration desk on the second floor of NSF (2415 Eisenhower Avenue, Alexandria, Virginia), no later than 7:30 a.m., to prepare for the day together. Be sure to

arrive at NSF early (we suggest arriving at 7 a.m.) to allow enough time to get through security.

- Guest Wi-Fi will be available, and there will be charging stations in the conference room. Instructions for accessing NSF's guest Wi-Fi will be printed on the badge you will receive when you arrive.

- We have created a template for you to record your thoughts during the reflection portion of each discussion. You may access and fill out the form here: https://go.edc.org/stemreflection. We will also have this form available in hard copy for those who prefer pencil and paper.

- Coffee, breakfast, and lunch will be provided.

We will provide the following materials:

- Note paper, pens, and pencils

- Chart paper for capturing participants' thoughts (please label each piece of chart paper with the discussion question number and your table number)

- Colored 4" x 6" sticky notes for participants, with a different color for each STEM role (policy, education, or business)

- A roster of participants for each discussion question

    Note: We'll keep regional teams together for all the discussions, but we'll vary the regions in each discussion group so that teams get to talk with different people throughout the day.

For Discussion Question 1, participants may refer to the "Five Priority Investment Areas" handout included in their packets.

For Discussion Question 2, participants should refer to the list of "10 STEM Aspirations" included in their packets.

For Discussion Question 3, you'll be provided with two documents: "Survey Responses About Impediments" and "Survey Responses About Improving Access to Resources." These summaries may help you anticipate some of the perspectives your participants will bring to the discussion.

IMPORTANT INFORMATION TO KEEP IN MIND

- Terms can get confusing, and we'll need to refer to them consistently—in particular, Priority Investment Areas and STEM Aspirations. The Priority Investment Areas are those from the prior 2013 STEM Strategic Plan; STEM Aspirations are the main themes that we wish to explore for the new Plan. Note that this meeting does not prioritize any of the aspirations above others.

- Your role may include reminding participants of the goals of the meeting. We'd like to hear from participants about what is most valuable and important to them regarding STEM education policy and programs in their state, and how states, territories, and tribal communities are prioritizing programs and policies in order to inform the next Strategic Plan.

- Participants might have incorrect information about what was in the last Plan. We want to hear their perspectives, even if their understanding of the details of the last Plan is not correct. Our responsibility is not to correct them but rather to let them reveal what they know. In fact, what participants know and don't know is important data for us.

FACILITATION GUIDELINES

- We want to set a tone that makes it okay to be unfamiliar with the 2013 STEM Strategic Plan or aspects of STEM education that are outside participants' experience.

- We don't want to settle for simple responses to our questions, but rather to probe with follow-up questions such as, "Can you tell me more about why you think that?" and "How did that come to be?" This probing will allow us to understand the challenges, questions, and concerns of participants related to federal policies and practices.

- Abigail will set up each discussion for all the participants. She will also remind people that we likely won't have enough time to say all there is to be said. However, your job is to make sure that all the topics get participants' attention, which may mean occasionally having to cut someone off or encourage someone who hasn't spoken yet to share their opinions.

- At the end of each discussion, we have reserved 10–15 minutes for both you and the participants to reflect on the discussion and record your thoughts. Participants can also record important ideas, observations, etc., as the discussion unfolds. Participants will record their thoughts on sticky notes, which they should label with their state, territory, or tribal community. To gather as complete and robust a record of the content of the conversations, we ask that you strongly encourage participants to record their thoughts on the stickies as often as they like during each discussion—there's no need to wait until the reflection portion to do so. Similarly, if someone in your group says something that you believe is really important, encourage them to write it on a sticky note and add it to the chart paper.

- We will rely heavily on your reflections during the debrief session. The clarity and completeness of your reflections and recollections will be key to EDC creating a complete and accurate summary of the day's content. The systems we have devised—the facilitator template available electronically and in hard copy, chart paper, sticky notes for participants to record their thoughts, opportunities for the group to reflect on what they thought was important after each discussion, and a debrief session with all facilitators immediately following the Summit—should help you with this.

- At the end of the day, from 3:30 to 5 p.m., you and other facilitators will gather in groups of six or seven and go through the important high points of the discussions together, using your own notes, the chart paper sheets, and the sticky notes as prompts.

- Facilitation notes specific to each question begin on the following page.

QUESTION 1:

What was the impact of the past (2013–2018) Federal Five-Year STEM Education Strategic Plan on regional sTEM programs and policies?

Timeframe: 8:40–9:45 a.m.

Here is a breakdown of how much time to allot for your discussion of Question 1:

- 5 minutes: Overview of the session by Abigail Jurist Levy, who will introduce today's discussion to the participants and set the stage for the conversations you will facilitate
- 5 minutes: Introductions—ask your table group to share their names, which state or territory they represent, and their role regarding STEM
- 40 minutes: Discussion of Question 1 (see below)
- 15 minutes: Reflection and synthesis (see below)

Background Information

The information below is provided to orient you to the purpose of this discussion and to help you anticipate topics or issues that might arise:

- The information gathered from this question helps us determine what sort of foundation we're building on with the states, territories, and tribal communities, which could range from perceptions of great impact to perceptions of no impact.
- Attendees might shrug off the first Plan as inconsequential to their STEM activities because they may be unaware that it was the source of funds to support, say, a university operating a Noyce program in their state, professional development for nonformal educators, and so on.
- *Lack of awareness* is a key finding for us and can help us learn how we can better publicize the new Plan. In order to build our case for an outward-looking new Plan, we need to gather evidence of the level of awareness about the prior Plan and the factors that explain it.
- This question may also elicit from attendees the goals of the prior Strategic Plan that remain pressing and important and that we should retain or re-emphasize in the new Plan.

Discussion of question 1 (40 minutes)

Use the following questions to prompt discussion:

1. What made the 2013 STEM Strategic Plan useful?
2. What prevented it from being more useful than it was?
3. What programs or policies were put into place in your region as a result of, or in reaction to, the 2013 Plan?

4. To what extent was alignment with the Plan an explicit objective?

5. Why was alignment with the Plan important, or not important?

6. Were there other factors that influenced decisions about the direction of STEM education initiatives that the writers of the new Plan would benefit from understanding?

7. To what extent did the 2013 Plan drive the progress these programs have made?

8. How could the Plan have helped address the challenges that your region experienced?

For participants who can't respond because they don't know the answer, suggest that they look at the "Five Priority Investment Areas" handout and think about whether these Areas inspired the development of programs or policies in their region. Ask:

1. What major changes or advances in STEM education have you seen in the last five years?

2. What motivated those changes or advances?

3. What obstacles were encountered along the way?

4. What role did local, state, or federal policy play in supporting or hindering these changes or advances?

Reflection and Synthesis (15 Minutes)

Spend five minutes doing the following:

- Ask participants to label their stickies with their state, territory, or tribal community, record their ideas about what points were most important on their stickies, and add them to the chart paper.

- Record your own reflections and notes via the template provided by the EDC team; this may be done either electronically (https://go.edc.org/stemreflection) or by hand. Your notes can focus on the tenor of the conversation, themes or patterns that seemed important, or anything else that seems worth recording.

   Note: Your reflections will not be added to the chart paper, but rather will be used to help remind you about the discussion during the post-Summit facilitator debriefing.

Spend 10 minutes doing the following:

- Have your table group look at the sticky notes and draw conclusions about the two to four most important points made by their table.

- Record their conclusions by adding them to the electronic or paper template.

For the facilitator debrief of question 1

Be prepared to describe the following:

1. The nature and extent of peoples' familiarity with the 2013 STEM Strategic Plan

2. Their understanding of its importance

3. Why alignment with the plan was important, or not

4. Whether and how people thought the Plan influenced the establishment of STEM education programs or policies in their region

5. Whether and how people thought it influenced the progress of programs or policies in their region

6. Whether there were any patterns according to participants' STEM roles or by region

QUESTION 2:

What are the emergent trends and priorities of the STEM Community, and how might they factor in to the prospective 2018–2023 Federal Five-Year STEM Education Strategic Plan?

Timeframe: 9:55–11:25 a.m.

Here is a breakdown of how much time to allot for your discussion of Question 2:

- 5 minutes: Introductions—ask your table group to share their names, which region they represent, and their role regarding STEM

- 20 minutes: Regional teams identify their top three aspirations and their number-one priority (see below)

- 20 minutes: Regional teams share their lists and answer questions (see below)

- 30 minutes: Whole-table discussion (see below)

- 15 minutes: Reflection and synthesis (see below)

Background Information

The information below is provided to orient you to the purpose of this discussion and to help you anticipate topics or issues that might arise:

- Question 2 is the key question behind the entire event. After having spent the first session dissecting the shortcomings of the 2013 Plan, attendees will be primed for "coaching" us on how the 2018 Plan can be better. Our goal is to glean from this discussion a list of priorities for the new 2018 Plan.

- Principally, we want to hone in on the following:

  - What are the high-frequency priorities of each region?

  - Why those and not others?

  - Are there short-term and long-term priorities, and how do they differ? (For example, re-skilling or upskilling is short-term imperative for laid-off workers, while fostering diversity is a long-term necessity.)

- Don't let the conversation get waylaid by the topic of funding. Although it's true that most progress will have much to do with funding, we mustn't let that become the focus. If this topic begins to distract participants, you might suggest something such as, "In the current austere funding environment, maybe we can think of utilizing existing funds in new or different ways." Push attendees to be both realistic and imaginative.

- Participants will find the "10 STEM Aspirations" handout (in their packets) helpful.

Regional teams identify top three aspirations (20 minutes)

Ask regional teams to sit together if they are not already, and have them pick a spokesperson who will share the result of each team's discussion. Give them 20 minutes to identify their top three aspirations for the next five years from the list of "10 STEM Aspirations" and to then identify their top priority. They don't have to agree, but they all have to be familiar with one another's point of view. Have them record their top three aspirations on a sticky note (labeled with their state, territory, or tribal community) and put a star by their highest priority. When the 20 minutes are up, have each spokesperson add their sticky note to the chart paper.

Regional team reports (20 minutes)

Have each spokesperson share where their team landed and answer the following questions, with help from their teammates if needed:

1. How did you decide on these aspirations?
2. Why those and not others?
3. Where did you agree, and where did you have differences of opinion?
4. Was anyone's mind changed during your discussion? If so, what convinced them?
5. Are some aspirations shorter-term and others longer-term?
6. What's at the bottom of the barrel, and why? Could this aspiration be important but at a later time?
7. Are there goals that are important for your region that are missing from this list? What are they, and why are they important?

   Note: Some questions may be less relevant than others, and there may not be time to discuss each question. Use your best judgment, and keep the discussion moving.

Whole-table discussion (20 minutes)

Ask your group to keep in mind the posted sticky notes and the discussion so far as they discuss the following questions:

1. What themes emerged across regional teams?
2. What were the most common priorities?
3. Why are these trends important for the writers of the next Plan to know about?

4. What are the most significant opportunities in your region that will enable you to be successful and that the writers of the next Plan should be aware of?

5. What are the biggest challenges that will make it difficult for your region to be successful that the writers of the next Plan should be aware of?

Document their responses on chart paper throughout the discussion; you will use these notes for the post-Summit facilitator debriefing.

Just before the end of the discussion, ask if anyone wants to change any of their priority aspirations as a result of the conversation, and take note of what occurs.

Reflection and Synthesis (10 Minutes)

Spend five minutes doing the following:

- Remind participants to label their stickies with their state, territory, or tribal community, record their ideas about what points were most important on their stickies, and add them to the chart paper.

- Record your own reflections as you did during Discussion 1, either using the paper form or the online template (https://go.edc.org/stemreflection).

    Note: You will refer to these notes during the post-Summit facilitator debriefing.

Spend five minutes doing the following:

- Have your table group look at the sticky notes and draw conclusions about the two to four most important points made by their table.

- Record their conclusions by adding them to the electronic or paper template.

For the facilitator debrief of Question 2

Be prepared to describe the following:

1. The variation you saw in peoples' views within and across regional teams, whether these differences were large or small, and where you saw patterns (e.g., among STEM roles)

2. Any themes you saw in their rationales for why they chose certain aspirations and not others

3. How many people changed their vote at the end

4. How well the team members seemed to know one another, how engaged they were in the discussion, and how comfortable they were with one another

QUESTION 3:

What is the Federal government's role and responsibility in supporting regional STEM education programs and policies?

Note: Regional participants will be joined in this discussion by the teacher and mentor awardees. Ask awardees at your table to sit with other members from their region so they can confer easily.

Timeframe: 1:00–2:00 p.m.

Here is a breakdown of how much time to allot for your discussion of Question 3:

- 5 minutes: Overview of the session by Abigail Jurist Levy, who will introduce this discussion to the meeting participants and set the stage for the conversation you will facilitate
- 5 minutes: Introductions—ask your table group to share their names, which region they represent, and their role regarding STEM
- 30 minutes: Discussion of Question 3 (see below)
- 15 minutes: Remaining questions (see below)
- 10 minutes: Reflection and synthesis (see below)

Background Information

Before this discussion, you will have in hand the survey responses to questions about the major impediments that regions face in terms of achieving their STEM aspirations, and what could be done at the federal level to make it easier for STEM leaders to access resources. The information below is provided to orient you to the purpose of this discussion and to help you anticipate topics or issues that might arise:

- You will need to keep this conversation focused on STEM and the federal responsibility to support STEM education, and prevent the conversation from drifting to other issues.
- It is our responsibility as STEM leaders to provide a "true north" regarding future STEM priorities and the federal government's role and responsibility in helping states succeed.
- What we really want to determine is what, beyond funding, the federal government should do to help regional STEM efforts:
  - Do participants think the federal government is needed to do research on the STEM condition that could then be used to craft state policies?
  - Do participants have in mind some federal policies that inhibit their own STEM work?
  - Do they wish for some new federal policies that would help them do their STEM work?
  - Are communication and information access a big deal in terms of knowing what the policies are and what programs are currently available?

- Do they need the federal megaphone to help make the STEM imperative more visceral in their region?
- Do they see inconsistencies across agencies, such as between Labor and Education, that need to be ironed out internally?
- Do participants wish for national STEM standards?
- Do they wish for less intrusiveness by the federal government regarding the use of funds, such as Perkins or Pell?

Discussion of Question 3 (30 minutes)

You could begin this discussion by saying, "Before the Summit, participants were asked a series of questions about STEM priorities and challenges in their region. The responses about challenges included some of the following." (Refer to the "Survey Responses About Impediments" document in your packet.) Ask, "Do these challenges resonate with you? If so, how?"

Prompt discussion of Question 3 by posing the following questions:

1. Besides providing funding, what could the federal government do to support you in addressing these challenges and improving STEM education?

2. How could the federal government do a better job of helping states, territories, and tribal communities identify and access resources for strengthening STEM education?

   Note: Refer to the "Survey Responses about Improving Access to Resources" document in your packet, as needed.

3. What "do's and don'ts" advice would you give the federal government when implementing any of these approaches?

4. If the 2018 STEM Education Strategic Plan were to make a positive difference for STEM in your region, what *must* it convey, and what should it *not* communicate?

5. Many different roles related to STEM education are represented here at this table. How can we work together to advance STEM education by making the most of one another's expertise?

Remaining Questions (15 Minutes)

Wrap up the discussion by posing the following questions:

1. What have we not had time to talk about today?

2. What important messages have you not had a chance to convey?

Encourage participants to email Jeff Weld (Jeffrey.D.Weld@ostp.eop.gov) or Abigail Jurist Levy (alevy@edc.org) and let them know about anything they haven't had a chance to share during today's discussions.

Reflection and Synthesis (10 minutes)

Spend five minutes doing the following:

- In their regional groups, have participants record the points they thought were most important on their sticky notes (remind them to include their state, territory, or tribal community on their stickies), and add them to the chart paper.

- Record your own reflections as you did during Discussions 1 and 2, either using the paper form or the online template (https://go.edc.org/stemreflection).

Spend five minutes doing the following:

- Have your table group look at the sticky notes and draw some conclusions about the two to four most important points made by their table.

- Record their conclusions by adding them to the electronic or paper template.

For the facilitator debrief of Question 3

Be prepared to describe the following:

1. The implications for the new 2018 STEM Education Strategic Plan with regard to:
   - outreach and communication
   - federal supports outside of funding
   - any patterns that emerged
2. How easy or difficult it was for participants to keep their focus on STEM
3. What participants wanted to share at the end that hadn't been covered already

APPENDIX D
Methodology for Analysis of Data from the Discussion of Question 1 and additional findings

METHODOLOGY

To best understand the important themes that emerged from this discussion, notes from the facilitators' focus groups were reviewed. This enabled the research team to understand the nature of the discussions; to then develop, test, and refine a set of codes that accurately reflected the primary and secondary ideas that were expressed; and finally to categorize all the points made during the focus groups to ensure that each was accounted for by a code that accurately reflected its intent.

In addition, the facilitators' post-discussion written reflections were reviewed, and the participants' sticky notes were selectively reviewed in order to further confirm, refine, or revise the facilitators' characterizations of the main themes.

ADDITIONAL FINDINGS

Differences by region or role in views about the prior Plan. Neither facilitators' reflections nor participants' notes indicate clear patterns or differences in perspectives about the prior Plan by education, business, or policy sector. One facilitator said explicitly, "I didn't see, across all three questions, much difference in opinion between industry, education, and policy folks." Instead, data suggest that there were some differences in views by level of jurisdiction in participants' roles (e.g., local versus state versus national-level roles). As noted above under "Awareness of the Previous Plan," individuals with a federal purview and/or statewide STEM policy responsibilities may have been more likely to be aware of the prior Plan.

There is also some evidence that views and awareness of the prior Plan may have varied depending on whether a state had the resources and desire to pursue federal or other sources of funding for STEM initiatives. A facilitator quoted an attendee who observed a pattern in states' STEM strategies that tablemates seemed to readily accept:

> … one of the people at the table made a characterization that the majority of the people then agreed with after he said it. And he said, "Really, if you want to look at how different states approach it, you look at three things: some states form 501(c)(3) entities, other states form the state department of education or similar organizations, and then other states didn't have enough resources to develop any specific STEM state-based activities." And after he said that, there was a lot of agreement, and that seemed to be where the views either converged or diverged. More so that way than along educator versus policy versus the personal kinds of things. It seemed to have to do more with the category a state fell in, and if they formed 501(c)(3) entities, they applied for certain kinds of funding available through the Federal Government and other sources. And that group seemed to

be much more aware and interested in alignment with the Federal Government. Whereas the second group forming the state department, those were the ones that tended to say, "We know what our state needs, and we don't necessarily need a federal plan because we know what we want to do." And the third group just basically [said], "We don't have enough money to really do too much, so we didn't know about it and we haven't done much." So, that was a definite pattern that people agreed to once it was pointed out. (Facilitator)

In addition, another facilitator noted a possible urban versus rural divide, with rural places reporting less impact due to lower awareness of STEM and limited access to STEM resources.

This is another place where there was a strong divide between the rural people and the urban-suburban people in terms of the impact on what happened. There was a sense that the rural people didn't see it change, and some of that related to the fact that there's lack of awareness among rural people about what the STEM workforce is. So, it's a lack of awareness and access. And so the idea was made that there needs to be a way of engaging families. We tend to think of engaging students and teachers and groups, but it's really families because families are the ones that impart the notion of what's possible. And they don't have that accordance. (Facilitator)

APPENDIX E
Methodology for Analysis of Data from the Discussion of Question 2 and additional findings

METHODOLOGY

Below we describe how we determined the priority ranking of the STEM aspirations and how we identified the key themes, challenges, and opportunities identified by participants.

RANKING THE PRIORITY OF STEM ASPIRATIONS

Each table group was asked to discuss and rank the importance of the 10 STEM aspirations, which are summarized in Table 9 below. Participants were asked to first rank the importance of each aspiration for their own state, and then designate top priorities, if possible.

Table 9. Abbreviated STEM education aspirations

1	Expand partnerships of educational entities and employers through:
1a	Work-based learning opportunities, including pre-apprenticeships, apprenticeships, intern-ships, and job shadows
1b	Partnerships that support re-skilling and upskilling of the under-employed, retirees, etc.
1c	Expanding industry-recognized credentialing for STEM education programs
1d	Offering Teachers-in-Workplace experiences
1e	School+Workplace collaborations at the K–12, certification/credentialing, two-year, four-year, and graduate levels
2	Foster STEM ecosystems that unite all stakeholders across communities and regions
3	Advance innovation and entrepreneurship education through approaches such as business start-up incubators
4	Promote the use of digital platforms for teaching and learning
5	Weave computational thinking principles universally across grade levels and school subjects
6	Promote digital literacy and fluency and cyber-safety practices
7	Increase diversity and inclusion of all Americans in STEM programs
8	Support the contextual integration of the mathematical sciences across grades and subjects
9	Usher a new era of transdisciplinary, or convergent, study across STEM (and beyond)
10	Erase artificial boundaries between traditional college-preparatory and career technical edu-cation and between formal and informal learning

Arriving at the ranking of aspirations was a multi-step process. First, an analyst reviewed all Discussion 2 facilitator reflection forms (12 completed forms from 18 facilitators). In a matrix of STEM aspirations by state, the analyst marked each time facilitators noted that participants within a state endorsed a STEM aspiration with a numerical ranking (such as first, second, or third priority) or more generally as a "priority" or "important." Rankings and priority designations were noted for individual states when this information was available. In cases where rankings and priority designations were noted by facilitators as summary designations for all states at the discussion table, the designations were entered into the matrix for each state at that table. Based on facilitator reflection questionnaire data, STEM aspiration endorsements were recorded for 32 of the 55 participating states.

In a second step, multiple analysts reviewed all the individual sticky notes and flip chart notes recorded by participants at each table. In a second matrix of STEM aspirations by state, analysts marked each time the stickies and flip chart notes indicated that participants within a state endorsed a STEM aspiration with a numerical ranking or as a priority. When participants' notes suggested that two or more aspirations should be combined or were similar in priority level, each aspiration was marked as having received one vote. Based on the stickies and flip chart data, STEM aspiration endorsements were recorded for 48 of the 55 participating states.

In a third step, the data in the first and second matrices were combined. Analysts recorded each time the facilitators' questionnaires, stickies, or flip chart notes indicated that a state had endorsed a STEM aspiration with a numerical ranking or as a priority. Based on the combined data, STEM aspiration endorsements were recorded for 51 of the 55 participating states.[10]

In a final step, analysts calculated the total number of states and the percentage that endorsed each STEM aspiration within each U.S. state. These results are shown in Table 8 in Appendix B.

IDENTIFYING THE AREAS FOR IMPROVEMENT

A second analysis was conducted to understand and characterize the nuances of the discussions regarding STEM aspirations and, more specifically, to document the thinking across participants that led to the emergence of the highest priority aspirations. Three members of the research team reviewed the available data sources and highlighted the main themes that emerged, including areas of general agreement, common responses, and areas where participants disagreed. This team then met to discuss the patterns that emerged through this highlighting process, and generated an initial set of themes from the discussion. Next, the team members returned to the data once more to examine the discussions around those aspirations that were ranked highest across all states and discussion groups. Team members met once again to review common patterns and to generate a second list of themes that were specific to each of the top-rated aspirations.

Finally, all comments from the stickies were transcribed into an Excel spreadsheet, and the fit with the set of themes developed earlier was tested. In this process, two analysts revised and refined existing themes and identified several new ones. Further, the Areas for Improvement were grouped into three categories: STEM Teaching, System Capacity, and Policy Drivers.

10 Representatives of Arizona, California, and Nevada were at the same discussion table and did not prioritize the STEM aspirations that were provided; instead, they generated their own thematic priorities. Priority endorsements from New Jersey were not indicated by the table facilitator or on stickies and flip chart notes.

APPENDIX F
Methodology for Analysis of Data from the Discussion of Question 3

IDENTIFYING THE CHALLENGES AND OPPORTUNITIES FOR FEDERAL LEADERSHIP

Similar to the process used to identify the Areas for Improvement, two members of the research team reviewed the available data sources and highlighted the main themes that emerged regarding challenges that will affect the impact of the Strategic Plan, and how the federal government could have a positive influence on the challenges that were emerging. The team identified areas of common sentiments, similar responses, and areas where participants disagreed. The team then met to discuss the patterns that emerged through this highlighting process, and generated an initial set of topic areas with broad definitions and descriptions. Next, the team members returned to the data from Discussions 1, 2, and 3 to examine the content, and refine and further define the challenges that were emerging.

Finally, all comments from the stickies were transcribed into an Excel spreadsheet, and the fit with the set of challenges developed earlier was tested. In this process, three analysts made a final review, and a final set of five challenges were described with evidence drawn from the participants' and facilitators' data.

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