Reflections on the National Academies Taking Stock of Science Standards Implementation Summit: Teacher Education and Professional Learning

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Introduction

The Science Standards Implementation Summit panels summarized in this paper focused on supporting teachers and teaching—specifically, on initial teacher preparation and on ongoing professional learning. The conversations within and across panels recognized that teacher preparation and teacher professional development operate within a larger educational system; teacher learning happens across these two categories and within that larger educational system. Considering these two panels as separate conversations would ignore the reality of the larger system they occupy while diminishing the potential impact of our collective work on the implementation of the NGSS vision. While unique points from each panel's discussion are highlighted, when possible, this paper identifies themes that emerged across the panels' discussions.

The panels' discussions reflected three key themes that were mirrored, in different ways, throughout the Summit. These themes include:

1. The crucial goal of making equity a priority in science education
2. The importance of attending to coherence across numerous dimensions of the educational system writ large
3. A suite of approaches that can play a role in working toward equity and coherence, including partnerships and collaborations, the use of high-quality instructional materials, and engaging teachers and learners in and with teaching practices.

In recognition of the need to conceptualize teacher preparation and teacher professional development as parts of a larger system, we unpack how these panels illustrated these themes,

both individually and collectively, and we elaborate on the themes based on the literature and the broader work of the science education community.

Theme 1: Working toward Equity in Science Education in Teacher Education and Ongoing Professional Learning

Panelists raised numerous important issues related to working toward equity within the auspices of teacher education and professional learning.

One issue relates to the teacher workforce. In the teacher education panel, panelists discussed the systemic racism that is baked into the teacher preparation system. They raised the point that completing student teaching is essentially an unpaid job, so only students with financial resources are able to complete the student teaching requirement. Historical wealth gaps mean white students are more able to complete a traditional teacher education program than are students of color. This exacerbates the longstanding mismatch between teachers and their students (NASEM, 2020). Panelist Todd Campbell noted that in his predominantly white institution, he and his colleagues “evaluate our program, the structures within our program, think about how they could be more inclusive and push back against the systemic racism that’s part of it”. Another panelist, Melissa Braaten, noted that in her state, educators fought to change the law so that student teachers could be paid—but she also commented that it is unresolved whether the school or the university bears the responsibility of the cost.

Another important equity-focused issue raised in these panels was related to enhancing the critical consciousness of teachers. The previous panel of the Summit, Centering Student Experiences, highlighted the need for teachers to value students’ lived experiences as well as creating learning spaces where students’ experiences are leveraged and respected. This significant shift in classrooms was described by panelist Enrique Suárez as experiences that “create opportunities for self-deliberation instead of just using students’ experiences as stepping stones towards dominant knowledge and ways of knowing”. However, supporting teachers to

create and effectively facilitate these opportunities requires that teachers reexamine their own role in systems that have historically oppressed particular groups. Preservice and practicing teachers alike need to consider who they are, what they prioritize, and how this shapes their actions as teachers (and how this meets, or does not meet, their students' needs). Teacher professional development panelist Julie Yu stated "the insidiousness of systemic oppression is that we are all complicit, because this is our ecosystem. . . it is historical, and we are used to it, it is normalized, so it is hard to see." All teachers in the system, preservice and classroom, need opportunities to evaluate their own assumptions about students and what it means to include student voice in their classrooms.

The teacher education and professional learning panels discussed the importance of developing partnerships to leverage resources and develop high quality teacher learning experiences. Panelists discussed using collaborative community partnerships to support teachers in learning about children and youth and their families (a topic discussed further in other sections of this paper, as well). For example, teacher education panelist Braaten described a first-year course that involved having preservice elementary teachers work in partnership with community organizations on "interest-driven STEM experiences that the families want to do", such as creative computing. Teacher professional development panelist Yu advocated that we expand our partnerships to include collaborators from outside our typical spheres of influence as a means of learning with and from individuals and organizations with diverse perspectives (Exploratorium). Teacher education panelist Thomas Philip provided a cautionary note about engaging in partnerships where the expertise of all partners is not acknowledged or valued. Often the assumed "expertise" of teacher educators, researchers and school site leads can lead to power dynamics that diminish the power of the partnership itself.

Teachers also, of course, need to learn to engage in equity-oriented teaching practices. For example, teacher education panelist Lizette Burks discussed her use of high-leverage practices in practice-based science teacher education (available via TeachingWorks; see Davis

& Marino, 2020, for more about the practice-based approaches supported by these materials) and how she ensures that she works on those high-leverage teaching practices in conjunction with work on Chapter 11 from the *Framework for K-12 Science Education* (NRC, 2012), which of course is the chapter focused on equity.

A final set of issues has to do with how educators conceptualize “equity”. As discussed earlier in the Summit, it is important to not make “equity” a catch-all, but rather, to be clear about one’s meanings for it, and its purposes. Teacher education panelist Philip discussed how he works with colleagues in teacher education on understanding the purpose of teacher education in a democratic society. He further commented on the complicity of *science* in the inequities of society, saying, “[S]cience as we know it today, is fundamentally integral and co-constitutive of some of the inequities and injustices that exist. So we fundamentally have to change science as we know it.”

While panelists did not explicitly explicate the *who* of (in)equities in science teaching and learning, the concurrent chat highlighted the importance of thinking broadly about who we mean in conceptualizing these issues. Based on one recent articulation, “historically marginalized groups” could include “Black, Brown, and Indigenous children and other children of color; children with learning disabilities and/or learning differences; emergent multilingual learners; and children marginalized on the basis of gender” (NASEM, 2021). One participant in the chat particularly highlighted the importance of not losing sight of children with learning disabilities and/or learning differences.

Some panelists discussed how they work to support teachers in developing these ideas about equity and science. For example, teacher education panelist Campbell discussed how he uses Philip and Azevedo’s (2017) description of the discourses of science education with his preservice teachers, to help to legitimize a range of ways of thinking about what counts as science. These discourses were used as a starting place for an equity framework presented in

the recent NASEM report on preschool through elementary science and engineering (NASEM, 2021). In that report, these are framed as “four approaches to equity”, namely:

1) increasing opportunity and access to high quality science and engineering learning and instruction;
2) emphasizing increased achievement, representation, and identification with science and engineering;
3) expanding what constitutes science and engineering; and
4) seeing science and engineering as part of justice movements.

These four approaches to equity might serve as a helpful framework for teacher education and professional learning experiences oriented toward the crucial goal of supporting teachers in learning to teach science toward justice.

Theme 2: The Need for Coherence in the Educational System in Teacher Education and Ongoing Professional Learning

Panelists identified two main issues related to the need for (or lack of) coherence in the educational “system”, and how this (in)coherence relates to teacher education and professional learning.

First, there is the well-known “two worlds” problem (Braaten, 2019) in teacher education--the notion that the ideas, practices, and strategies that preservice teachers learn in their university-based teacher education courses are disconnected from the realities of K-12 classrooms. Teacher education panelists Braaten and Philip both spoke about the need to reframe this problem—to use the disconnects, when they exist, as opportunities for reflection and growth. As Philip put it, “We want preservice teachers to think about the ethics of practice, who benefits, who is marginalized, under what conditions with particular practices. So how do we potentially use these apparent misalignments [between school and university] as an opportunity for preservice teachers to learn how to engage in dialogue about their practice, and

how might this be another way in which we engage in mutually beneficial institutional transformation across the university and at our partner schools?".

Second, multiple panelists spoke, from different angles, about the need to think programmatically and systemically about teacher education, professional learning, and K-12 education. For example, teacher education panelist Philip highlighted the need "to elevate the everyday programmatic work, the seemingly unremarkable work" of a teacher education program, and to think about the connections such programmatic work requires. Philip went on to discuss the need for coherence across all elements of a program, asking:

> [H]ow do we create programmatic systems where both teacher educators and pre-service teachers can thrive as teachers and learners? … [A first step for my program] was working to ensure that the pieces fit together. So how do courses complement each other, how do they complement field experiences, how were they integrated? ... The second piece is how we as faculty instructors, supervisors, cooperating teachers came to see our role and others' roles through a programmatic lens.

The role of school leaders as an integral part of a teacher's ability to enact the vision of the NGSS was highlighted by several panel members. Teacher professional learning panelist K. Renae Pullen noted that school leaders are often left out of professional learning, leaving them with little understanding of the new instructional approaches their teachers are trying to implement. Yet, these leaders are responsible for evaluating teachers as they develop their understanding of the NGSS and how to implement the new standards. While the panels focused on teacher learning, early field experiences and student teaching occur within schools and in classrooms where this tension plays out. School leaders who understand what implementing the NGSS (and related standards) entails and support teachers in their professional learning efforts are an important factor in the system's ability to present a coherent path of teacher learning. Teacher professional development panelist Jody Bintz summarized the issue: "As teachers develop a vision for what this kind of approach to teaching and learning can look like, we need

our leaders to develop that same kind of vision. We need to support them with the systems that can help get them there."

To us, this work of thinking programmatically is even more important in elementary teacher education, because the students in such programs are learning to teach every subject. In addition to juggling multiple content areas and pedagogies, there are often programmatic structures that limit a teacher's ability to enact standards as intended. For example, district and site policies can reduce the amount of time available for teaching science. At times, this restriction is implied while at other times school schedules explicitly promote the exclusion of science teaching. This is often the result of policies that unintentionally shift instructional time to reading and mathematics in the elementary grades to provide additional support for language development or other "remediation." At the secondary level, systemic approaches to professional learning, or lack thereof, were cited as challenges to NGSS implementation. Teacher professional learning panelist Stacey van der Veen spoke of the lack of a system-based approach to professional learning that often results in a single teacher representative in teacher workshops that lack a team to collaborate with, site-based demands or expectations that diminish their ability to affect change at their site or even their own classroom. Across levels, the role of the principal is crucial in supporting meaningful instruction in science.

In the chat happening in concert with the panels, Summit participants also noted the potential of thinking systematically or programmatically *across* teacher education programs—to build more of a system for teacher education. Finally, a theme throughout both panels was the importance of partnerships--among teacher education programs, districts, families, and community organizations.

Theme 3: Levers for Supporting Equity and Coherence in Teacher Education and Ongoing Professional Learning

Toward the goals of working toward equity and working toward coherence through teacher education and professional learning, panelists identified numerous strategies. What are levers that can help those who support teacher learning?

A first set of levers has to do with the importance of partnerships. One form of partnership discussed was partnerships with communities. For example, on the teacher education panel, panelist Burks talked about how partnerships with local school districts are key for “dreaming toward just futures”, and panelist Philip noted the importance of ensuring that partnerships between universities and school districts are mutually beneficial. Panelist Braaten, as described above, discussed the centrality of a community partnership for supporting her preservice teachers in learning more about the students and families with whom they work. A second form of partnership discussed in the panels was partnerships between schools and universities. For example, teacher education panelist Campbell talked about thinking about universities and schools as a unified system, to help both preservice teachers and mentor teachers navigate the divide both often find between teacher education and classrooms (as described above).

A second set of levers has to do with the kinds of teacher education pedagogies and tools used to support professional learning across the continuum. For example, Burks and Campbell on the teacher education panel discussed how they use rehearsals to support preservice teachers in learning to engage in teaching practice or what Burks referred to as equity-focused high-leverage practices. A similar discussion was seen in the teacher professional development panel in terms of how some teachers struggle translating what they have learned in professional development sessions into classroom practice. Several panelists spoke of the value of placing teachers in the role of learners during professional development as a tool to build knowledge about the vision of the *Framework* (NRC, 2012). Teacher professional development panelist Yu shared the philosophy of the Exploratorium: “We believe teachers deserve sustained professional learning that engages them in the learning experiences that help

them understand how they are being asked to teach." However, the professional learning experiences need to recognize and address the different needs of teachers, grade-level, local context, personal identities, in the same way we are asking teachers to do for the students in their classrooms.

Another example of a lever--prominent across both the teacher education panel and the professional learning panel--was the importance of building on high-quality instructional materials (see a recent special issue for several treatments of the importance of instructional materials; Campbell & Lee, 2021). Such materials provide teachers with a starting point, rather than expecting them to make up their instructional materials on their own. Teacher education panelist Campbell noted that using high-quality instructional materials allows preservice teachers to "spend time thinking about the moves we make in classrooms and how that's consequential", rather than taking their time only on instructional design. Teacher education panelist Braaten described how she and her colleagues work "in concert with mentor teachers and with teacher activists who are interested in making some principled adaptations to the instructional materials that are in use in K-5 settings", going on to note that one key goal of this adaptation is "to orient science towards equity and justice whenever possible". The importance of supporting preservice teachers in learning to use existing curriculum materials as a tool was amplified during the third day of the Summit in the session on the use of instructional materials.

The role of high-quality instructional materials in teacher professional learning was discussed in the teacher professional development panel as well. Panelist Bintz described high-quality instructional materials as an important lever in teacher learning and in ensuring equity and access for all students and teachers in the system. A common set of instructional materials can form the basis for professional learning communities. Instructional materials can also serve as a starting point for classroom teachers and allow teachers to collaboratively reflect on the strategies used to implement the shared materials and the impact those materials and strategies have on student learning. Panelist Pullen pointed to the availability of Open

Educational Resource (OER) materials, which has increased access to high quality materials and helped teachers shift to phenomena-based, three dimensional teaching. However, these materials have been slow to develop, and the lack of materials at particular grade bands has left many teachers struggling with outdated materials or attempting to build their own sequences.

Panelists also brought up the constraints that work against coherence and equity in supporting teachers' professional learning across the continuum. Some of these constraints—amply represented across many forums, including the new National Academies report, include time, resources, and money (NASEM, 2021).

The shift to the new standards is challenging, and we currently see uneven implementation from district to district, classroom to classroom. Teachers themselves do not always have access to the resources needed for implementation such as materials, time to learn and develop their understanding or compensation for that time and effort. Several on the teacher professional development panel argued that teachers' efforts need to be honored with appropriate financial compensation as they work towards implementation of the NGSS or other Framework-based standards.

Classroom teachers are being asked to implement new standards, new curriculum with "real" students in front of them. In many ways, teachers have been "re-noviced" and need time to implement the new shifts. Teacher professional development panelist Van Der Veen pointed to the tension many teachers face as they attempt to try something new while maintaining high expectations for the quality of instruction received by their students. Providing teachers the opportunity to be learners and grow their teaching knowledge and skill requires teachers to feel comfortable taking risks, trying new things and failing, and engaging in new learning experiences with the specific purpose of making their teaching more effective. Panelist Yu discussed the complexity of the NGSS which will require additional time and depth to cover. This means teachers will need additional time for professional development. However, time alone is insufficient. Teachers need to have supportive structures that allow them the security

and safety necessary to engage in deep learning and growth. Teacher professional development panelist Breigh Rhodes shared the value of collaborative planning time that allows teachers a space for sharing vulnerabilities and student-centered conversations, while panelists Bintz and Van Der Veen both highlighted the importance of school leaders who understand the new vision for science instruction and support their teachers in their implementation efforts.

Summarizing and extending some of the ideas raised in the panel, in the chat happening in parallel, several different dimensions of time were named, including:

- Instructional time and getting time for science on the classroom schedule (particularly an issue at the elementary level)
- Time for planning
- Time for professional learning
- Time for professional collaboration with colleagues
- Time to prepare for labs and hands-on science investigations
- The luxury of uninterrupted time

Each of these seems important to reckon with as we consider the effects of “time” on the teaching and learning of science.

Conclusions

These panels amplified and extended themes heard throughout the Summit about the importance of equity and coherence in our educational endeavors, with a focus on how teacher education and professional learning experiences can work toward these goals. Yet the panels also made clear that what we have isn’t really a system, but rather, a collection of disparate parts and actors working in good faith, but separately, on the same problems. In imagining just futures, these panels highlighted ways that incoherence could be addressed--for example, through better connections across teacher education institutions, schools, districts, policy makers, communities, community organizations, and families. New structures such as induction

programs or joint teacher education and professional learning opportunities for preservice and inservice teachers, might be needed. Science teacher education and development needs to share a common vision, but this vision needs to be in concert with the visions of the schools, districts and states where teachers work.

The panels also described structures and programs that are grounded in a history of inequity and privileged certain ways of knowing and learning. To genuinely work toward equity and toward justice, students need to be at the center of our work. All forms of professional learning--from initial teacher education to ongoing professional development--need to ensure that teachers are supported in making students, their backgrounds and resources, and their lived experiences central to their efforts.

One provocative question that was raised in the chat in October focused on the availability of resources and was revisited in the chat in December around the issue of capacity for change. In essence, the participant asked, how can the science education community think about what are reasonable goals given the *available* resources—rather than simply bemoaning the *lack* of resources? And what is the field's actual capacity for effecting change? While these questions clearly don't have easy answers, it may behoove the field to take these up seriously, as a way of guiding challenging decision-making.

Additional next steps for the field should work toward the overarching question of the Summit: How can we spread the kinds of good ideas shared during these panels, to ensure that preservice and inservice teachers have meaningful opportunities to learn about the Framework and to incorporate its vision, and the vision of the NGSS, into their instruction? However, another question emerged on day three of the Summit: as we move forward, what do we want to carry forward and what do we want to rethink and leave behind in order to develop the types of educational systems that support teachers in enacting the vision of the NGSS for all students? A concerted conversation about what to carry forward and what to leave behind, as we work with teachers at all grade levels and levels of experience, is crucially needed.

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