



DYNAMIC[®]
LEARNING MAPS

Interim Report on Development and Revision of Essential Elements in Science for the Dynamic Learning Maps Alternate Assessment System

Technical Report #20-04

12/17/2020

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I. Background and Purpose of the Report

The Dynamic Learning Maps® (DLM®) Consortium first developed Essential Elements (EEs) for science in 2014 to describe multidimensional science expectations for students with the most significant cognitive disabilities who take alternate assessments (Nash & Bechard, 2016). These EEs were the basis of the blueprints for the first DLM science alternate assessments developed on a rapid schedule to be ready for first operational administration in 2016. The initial EEs were limited in scope to meet that timeline and deliver assessments aligned to grade 5, middle school, and high school EEs. Given the expansion of DLM science from five states in 2014 to 18 states in 2019, the lessons learned in the field since 2013 about multidimensional science expectations for all students, and evidence from DLM science alignment studies, the consortium decided to revise and expand the science EEs to increase the breadth of coverage of the Next Generation Science Standards (NGSS).

The purpose of this interim report is to describe the process of developing the revised and expanded DLM science EEs, with steps completed through November 2020. We also describe the steps planned between December 2020 and states' adoption of the EEs, anticipated in 2022. When the draft standards are ready for state adoption, we will release a final report that includes all steps in the development of the resulting EEs

II. Essential Element Revision and Expansion

II.a. Purpose and Goals

The DLM Alternate Assessment System is based on the core belief that all students should have access to challenging, grade-level content. Similarly, the NGSS were developed to be inclusive of all students by helping them to “view science as relevant to their lives and future, and engage in science in socially relevant and transformative ways” (National Research Council [NRC], 2013, p. 29). Additionally, the NGSS were developed using the idea of learning progressions, offering students sustained opportunities to develop understandings of ideas and practices at an increasing level of depth and sophistication over multiple grades (Jin et al., 2019; NRC, 2007, 2012).

Based on the original DLM science goals and timeline, the first EEs were intentionally restricted in grades and depth of coverage within grades. This set of EEs represent prioritized standards among the initial group of states using the DLM science assessments. Given the number of EEs at each grade level, the number of items needed to measure each EE, and the total science assessment length requirements set by states to be similar to English language arts and mathematics assessments, it was necessary to prioritize and select the EEs to meet the test length requirement of up to 10 EEs per grade level. Therefore, this set of EEs addresses a subset NGSS Performance Expectations (PEs), not fully representing the breadth of coverage across the entire standards framework (Nash & Bechard, 2016). The 43 DLM science EEs originally developed and published are available on the DLM website at https://dynamiclearningmaps.org/sites/default/files/documents/Science/Science_EEs_Combined.pdf (Dynamic Learning Maps Science Consortium, 2015).

As a first step toward planning for EE expansion, we conducted an analysis of the initial DLM science EEs. Overall, as expected, 20.7% of the NGSS PEs were represented (see Table 1). Neither the kindergarten to fourth grade NGSS PEs, nor the NGSS engineering standards—the

Engineering, Technology, and Applications of Science (ETS) PEs—were represented within the existing DLM science EEs.

Table 1. *Percentage of Next Generation Science Standards (NGSS) Represented by All DLM Science Essential Elements*

Standards	Grade band			Total
	K–5	Middle school	High school	
NGSS Performance Expectations	78	59	71	208
DLM Essential Elements	9	14	20	43
% coverage	11.5	23.7	28.2	20.7

An external alignment study (Nemeth & Purl, 2017) found that two high school EEs were not aligned to the SEP of the corresponding NGSS PEs, and three middle school EEs were not aligned to the corresponding PE based on cognitive process dimension (the DLM equivalent of depth of knowledge). These five EEs were revised as part of the EE revision and expansion panel process.

To provide a more comprehensive set of opportunities for students with the most significant cognitive disabilities to engage in meaningful learning and application of grade-appropriate science knowledge and practices across grades K–12, we need to develop DLM science EEs that strongly align to all NGSS PEs. The intent of strongly aligning the DLM science EEs to all NGSS PEs is to establish rigorous and relevant expectations for the DLM student population while providing them more opportunities to make relevant connections between science and their own lives.

To achieve this goal, we engaged educators in a panel process we called an expansion and revision event. The three goals for the event were to

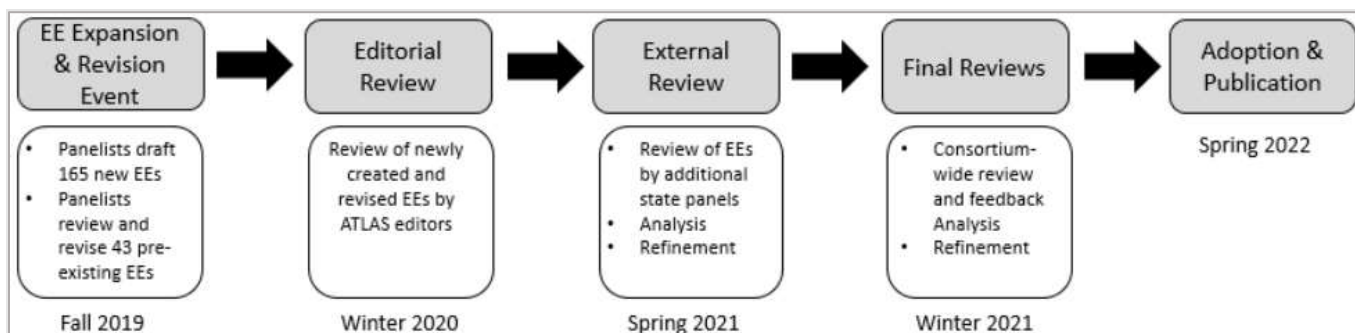
1. review and revise 43 existing DLM science EEs for strong alignment to all three dimensions of the NGSS (including the five EEs flagged in the initial alignment study)
2. draft 165 new DLM science EEs to fill gaps so the EEs represent 100% of the NGSS PEs
3. produce a set of DLM science EEs that represent a logical, vertical articulation across grade levels or bands, as well as a logical, horizontal articulation within a grade level or band, reflecting a similar structure as the NGSS

II.b. Overview of the Approach

We created a process for development of new EEs and revisions to existing EEs to ensure that the resulting products were clear, relevant, rigorous statements of expectations for what students with the most significant cognitive disabilities should know and be able to do in science. Figure 1 shows how the development process was conceived to include (a) a panel development meeting in which science and special education experts worked together to draft new and revised EEs, (b) an internal editorial review of the draft EEs, (c) an external review of the draft EEs by a separate group of science and special education experts, and (d) review and adoption by DLM state partners. This report includes preliminary descriptions of steps 1 and 2, which have been completed, and brief descriptions of the plans for steps 3 and 4, which are anticipated to be completed in 2021 and 2022. We will publish an updated report that includes

all four steps in the development process and additional evidence of the technical quality of the resulting EEs.

Figure 1. *Steps in the Essential Element (EE) Development Process*



II.c. Principles for EE Development

To successfully achieve the EE development process, we defined these specifications for the DLM science EE expansion and revision event:

1. Use overarching science concepts, themes, or questions as defined by published NGSS PE bundles to represent the breadth of the NGSS PEs.
2. Ensure strong alignment to the three dimensions of the NGSS.
3. Reduce the depth and complexity of each PE within the NGSS, maintaining a grade-appropriate level of rigor.
4. Use NGSS PEs and DLM documents to include robust connections to English language arts and mathematics.
5. Use principles of Universal Design for Learning (UDL) to ensure that EEs were developed with accessibility in mind.

II.c.1. Breadth of Coverage

Although the NGSS make high cognitive demands of all students, the multidimensional and cross-disciplinary nature of the standards provides students with many opportunities to connect and apply science ideas and practices both within and across domains and disciplines (Lee et al., 2014; NRC, 2012, 2013). Therefore, the standards—the PEs—are not intended to be taught in isolation (Achieve, 2016; NRC, 2013). Published PE bundles—groups of standards deliberately arranged and sequenced to organize instructional units—help students and teachers look for and find “the connections between ideas that naturally exist in the sciences” (Achieve, 2016, p. 5). The PE bundles integrate engineering into the science domains, scaffold content, allow students to build proficiency in all three dimensions of the construct in a logical progression, and coherently address all standards within a grade level or band (Achieve, 2016; NRC, 2013).

We used the PE bundles published by nextgenscience.org to guide the EE drafting process. DLM facilitators encouraged panelists to consider the overarching science concepts, themes, or questions, upon which the PEs were bundled to help panelists develop their own understanding of the scaffolding, cohesion, and logical learning progressions within the breadth and depth of the NGSS PEs.

II.c.2. Multidimensional Structure and Approach to Alignment

The NGSS were built around three distinct and equally important dimensions to support students' meaningful learning in science and engineering. Therefore, each standard—or PE—integrates a science and engineering practice (SEP), a disciplinary core idea (DCI), and a crosscutting concept (CCC). The integration of these three dimensions helps students build a cohesive understanding of science and engineering, as well as their interdisciplinary practices, over time (NRC, 2012, 2013). Additionally, this three-dimensional construct “offers multiple entry points for students who traditionally have not recognized science as relevant to their lives or future or have not been exposed to such opportunities” (Lee et al., 2014, p. 228).

In order to develop alternate academic standards in science for students with the most significant cognitive disabilities, DLM staff considered each of the NGSS dimensions and how they would relate at reduced depth breadth and complexity. This section provides an overview of each dimension and describes the guiding questions used to help develop panelists' understanding of each. DLM facilitators provided panelists resources relevant to the dimensions and encouraged panelists to consider guiding questions specific to each dimension. Additionally, DLM facilitators trained panelists to (a) determine whether or not existing EEs strongly align to all three dimensions of the corresponding PEs, (b) revise existing EEs to strongly align to all three dimensions of the corresponding PEs, and (c) strongly align drafts of new EEs to all three dimensions of the corresponding PEs. As such, panelists physically wrote the textual components of the new or revised EE that aligned to each dimension on separate pieces of paper as part of the final draft submission of each EE.

II.c.2.i. Dimension 1: Crosscutting Concepts

Crosscutting concepts bridge disciplinary boundaries, helping students to connect interrelated knowledge and common applications across the science and engineering domains through the lenses of unifying concepts and processes (NRC, 2012, 2013). These unifying concepts and processes “provide students with connections and intellectual tools that . . . can enrich their application of practices and their understanding of core ideas” (NRC, 2013, p. 233).

Seven crosscutting concepts are integrated into the NGSS (NRC, 2013).

1. Patterns
2. Cause and effect: Mechanism and prediction
3. Scale, proportion, and quantity
4. Systems and system models
5. Energy and matter: Flows, cycles, and conservation
6. Structure and function
7. Stability and change

The original DLM science EEs, developed in 2014, did not address these CCCs when the EEs were drafted or reviewed. Instead, the associated CCC was added at the publishing stage.

DLM facilitators and panelists leveraged guiding questions to ensure drafts of new EEs and revisions of existing EEs strongly align to the CCCs of the corresponding PEs. The facilitators and panelists used these three guiding questions specific to the CCC dimension:

1. What are the key aspects of this CCC?
2. What explanatory value does this CCC have?
3. How does this CCC provide authentic, meaningful connections to the SEP and DCI?

II.c.2.ii. Dimension 2: Science and Engineering Practices

Science and engineering practices are a broad set of iterative approaches that students use to establish, extend, refine, and demonstrate their understanding of the concepts and purposes of science. In particular, science and engineering practices are scientific inquiry, problem-solving, reasoning, and communication skills that students are expected to engage with to fully investigate, understand, model, and explain scientific and engineering ideas. Therefore, students “cannot learn or show competence in practices except in the context of specific content” (NRC, 2012, p. 218).

Eight science and engineering practices are integrated into the NGSS (NRC, 2013).

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

The original 43 DLM science EEs did not include the practice of asking questions or defining problems. The practice of asking questions instigates, guides, and sustains scientific and engineering developments in knowledge, understanding, and applications. It is also a crucial component of developing scientific literacy and habits of mind (NRC, 2012). Furthermore, the engineering practice of defining and solving local problems provides relevant connections to students’ lives and communities (Lee et al., 2014). Therefore, expanding the DLM science EEs to include all science and engineering practices provides students more opportunities to engage in meaningful scientific inquiry, problem-solving, reasoning, and discourse.

DLM facilitators and panelists leveraged guiding questions to ensure drafts of new EEs and revisions of existing EEs strongly align to the SEPs of the corresponding PEs. The facilitators and panelists used three guiding questions specific to the SEP dimension.

1. What does it mean to do the practice?
2. What are the essential components of this practice?
3. What possible intersections might there be with other practices?

II.c.2.iii. Dimension 3: Disciplinary Core Ideas

DCIs represent what students are expected to know. They describe the “fundamental ideas that are necessary for understanding a given [*science*] discipline (Achieve, n.d.),” as well as understanding “the relationships among science, engineering, and technology” (NRC, 2012, p. 29).

The disciplinary core ideas within the NGSS are grouped into four domains. Within each domain, the disciplinary core ideas are arranged by topic (NRC, 2012, p. 3; Brenneman et al., 2018).

1. Physical Sciences
 - PS1: Matter and its interactions
 - PS2: Motion and stability: Forces and interactions
 - PS3: Energy
 - PS4: Waves and their applications in technologies for information transfer
2. Life Sciences
 - LS1: From molecules to organisms: Structures and processes
 - LS2: Ecosystems: Interactions, energy, and dynamics
 - LS3: Heredity: Inheritance and variation of traits
 - LS4: Biological evolution: Unity and diversity
3. Earth and Space Sciences
 - ESS1: Earth's place in the universe
 - ESS2: Earth's systems
 - ESS3: Earth and human activity
4. Engineering, Technology, and Applications of Science
 - ETS1: Engineering design
 - ETS2: Links among engineering, technology, science, and society

DLM facilitators and panelists leveraged five guiding questions to ensure drafts of new EEs and revisions of existing EEs strongly align to the DCIs of the corresponding PEs.

1. What is the intended meaning of elements of the core idea?
2. Is there one idea or several separate ones in the statement?
3. What terminology is explicitly used in the core idea?
4. What peripheral ideas or terms are not essential for understanding the core idea?
5. Are there any commonly held ideas that differ in important ways from the scientifically accepted understanding?

II.c.3. Reduction in Depth and Complexity

DLM science EEs set high, actionable, and accessible academic expectations for students with the most significant cognitive disabilities. However, the NGSS that the DLM science EEs are based upon make high cognitive demands of all students. Therefore, adaptations to the NGSS PEs need to be made in order to develop DLM science EEs that are accessible to the DLM population, who are diverse in learning pathways, communication modes, and support needs. The goal for alternate academic standards is to remain strongly aligned with the general education standards while appropriately reducing depth, breadth, and complexity of expectations as appropriate for students with the most significant cognitive disabilities. The NGSS introduce a significant challenge for developers of alternate standards in that the reduction of depth, breadth, and complexity should be made across all three dimensions, sometimes in different ways and to different degrees, while maintaining the multidimensional expectations of each performance expectation. To help panelists reduce the complexity and depth of the NGSS PEs without losing the fundamental meaning of each PE, two resources were used: the [DLM Adapted Science and Engineering Practices](#) (DLM, 2016) and the [PBS KIDS Science Learning Framework](#) (Brenneman et al., 2018). *DLM Adapted Science and Engineering Practices* describes adapted NGSS SEPs that represent accessible and appropriate expectations for the DLM student population. This resource also articulates the practices across grade levels or bands, from elementary to high school. Additionally, the *PBS*

KIDS Science Learning Framework provides examples of how DLM students in kindergarten through second grade can appropriately engage with all three dimensions of the NGSS. Panelists used this resource mainly to develop the K-4 EEs.

Panelist dialogue and writing considered the original intent of the PE and the related vocabulary of key science content terminology. Panelists then determined how the standard could be reduced in complexity while retaining its core meaning. The designed writing process, defined for and practiced by panelists beforehand, started with reading the original PE first, followed by a close reading of each dimension to clarify their intended meanings. Next, panelists considered how to reduce the depth and complexity within each dimension using the resources listed above and lists of grade-level science vocabulary terms used in the NGSS. Panelists next wrote phrases for each dimension, and, finally, combined phrases to create a new PE.

II.c.4. Cross-Disciplinary Connections

Math and literacy skills are critical to constructing and developing students' science knowledge and skills (Common Core State Standards Initiative, 2012, 2013; NRC, 2013). Robust connections to these math and literacy skills already exist in the NGSS and are summarized in the appendices (NRC, 2013). Appendix L summarizes the connections to the Common Core State Standards for Mathematics and Appendix M summarizes the connections to the Common Core State Standards for English Language Arts and Literacy in History/Social Studies, Science, and Technical Subjects. Additionally, DLM learning map models connect English language arts, mathematics, and science through foundational nodes, which are included in all maps. Therefore, the expanded DLM science EEs will ensure coherence between students' English language arts, mathematics, and science literacy learning. These cross-disciplinary connections "are important for diverse student groups in the current climate of accountability policies that are dominated by reading and mathematics. The integration of these subject areas is particularly important for students from non-dominant groups who may be allotted fewer instructional hours in science due to these accountability practices" (Lee et al., 2014, p. 228).

II.d. EE Development and Revision Criteria

To help ensure the development of DLM EEs that set high, actionable, accessible, and measurable academic expectations for students with the most significant cognitive disabilities, facilitators and panelists used eight questions to guide their design decisions when writing and revising EEs.

1. Does the EE begin with an action phrase that aligns to a science and engineering practice?
2. Does the EE reflect the main concepts of the disciplinary core idea while reducing them in depth or complexity (i.e., vocabulary is reflective of reduced complexity without losing fundamental meaning)?
3. Does the EE include elements/vocabulary which align(s) to the crosscutting concept dimension?
4. Is the EE measurable?
5. Is the EE observable?
6. Is the EE broad enough to be adaptable for all learners?
7. Is the EE written so that the science concept is accessible for all learners?
8. Is the EE concisely written (does not include extraneous words which aren't needed to convey the science concept, e.g., clichés, slang or figurative language)?

II.e. Anticipated Results

In alignment with the goals of the expansion and revision event, as well as the defined specifications for the work produced at the event, DLM staff anticipated the panelists would produce 208 DLM science EEs that (a) represent 100% of the NGSS PEs at a reduced level of complexity and depth, (b) strongly align to all three dimensions within the standards, (c) contain cross-disciplinary connections, and (d) present logical articulations within and across grade levels or bands. Therefore, it was anticipated that panelists would review the 43 existing DLM science EEs, revise a subset of those 43 based on their review, (Table 2 and Table 4), and draft 165 new DLM science EEs (Table 2, *Note*: NGSS=Next Generation Science Standards. Table 3, and Table 4). We anticipated that some EEs might have been accepted after panelist review. Panelists were not given the option of rejecting an existing EE without drafting a revision or replacement.

Table 2. *Anticipated Results per Grade Band*

Standards	Grade band			Total
	K-5	Middle school	High school	
NGSS Performance Expectations	78	59	71	208
Anticipated reviewed/revised DLM Essential Elements	9	14	20	43
Anticipated new DLM Essential Elements	69	45	51	165

Note. NGSS = Next Generation Science Standards.

Table 3. *Anticipated Results for Kindergarten Through Grade 4*

Grade	K			1			2				3			4			Total
Domain	PS	LS	ESS	PS	LS	ESS	PS	LS	ESS	K-2 ETS	PS	LS	ESS	PS	LS	ESS	
NGSS PEs	4	1	5	4	3	2	4	3	4	3	4	8	3	7	2	5	62
Anticipated reviewed/ revised DLM EEs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Anticipated new DLM EEs	4	1	5	4	3	2	4	3	4	3	4	8	3	7	2	5	62

Table 4. *Anticipated Results for Grade 5, Middle School, and High School*

Grade	5				Middle school				High school				Total
Domain	PS	LS	ESS	3-5 ETS	PS	LS	ESS	ETS	PS	LS	ESS	ETS	
NGSS PEs	6	2	5	3	19	21	15	4	24	24	19	4	146
Anticipated reviewed/revised DLM EEs	4	2	3	0	4	4	6	0	4	10	6	0	43
Anticipated new DLM EEs	2	0	2	3	15	17	9	4	20	14	13	4	103

II.f. Methods

This section outlines the procedures for the DLM science EE expansion and revision event, which occurred in four phases: 1) panelist recruitment, 2) panelist and facilitator training, 3) writing and revision of EEs by panelists, and 4) process evaluation.

II.f.1. Event Participants

A total of 82 people participated in the three-day EE expansion and revision event, including 52 educators and governance board members from DLM partner states and 30 DLM staff members.

II.f.1.i. Panel

Panelists were recruited by DLM staff from a consortium-wide database of volunteer educators and nominations from DLM partner state governance board members. Panelists were eligible if they had experience teaching students with the most significant cognitive disabilities and/or science within a K–12 setting, or experience at the LEA or SEA level with the NGSS. Selection of panelists prioritized a range of experience, expertise across the three domains of science and grade levels, and geographic and demographic diversity where possible.

A total of 56 educators from the 20 DLM partner states were recruited to participate as panelists at the 3-day event: 24 elementary educators, 16 middle school educators, and 16 high school educators.

In total, 52 of the 56 recruited panelists participated in the event, with representation from twelve DLM partner states (Table 5). Areas of reported expertise among panelists are shown in Table 6. Panelists may have reported multiple areas of expertise.

Table 5. *Number of Participating Panelists for EE Expansion and Revision Event by State*

State	No. of panelists
Arkansas	7
Delaware	2
District of Columbia	3
Illinois	2
Iowa	6
Kansas	5
Missouri	10
New Jersey	4
New York	3
Rhode Island	3
West Virginia	6
Wisconsin	1
Total	52

Table 6. *Panelists' Reported Areas of Expertise*

Expertise category	No. of panelists
General education population	27
Special education population	25
Physical sciences	37
Life sciences	41
Earth and space science	36
High school	14
Middle school	16
Elementary school	23

The final report will include more detailed summaries of participants' qualifications.

II.f.1.ii. Panel Facilitators

In addition to the panelists, 30 DLM staff members attended the event, including 14 panel facilitators, the DLM science research lead, an accessibility specialist, two science subject-matter experts, two data entry specialists, and two support staff.

II.f.2. Training

Training took place both before and during the EE expansion and revision event, requiring panelists to participate in 3 to 5 hours of activities before and during the event. Additionally, approximately 10 hours of training for facilitators took place prior to the event.

II.f.2.i. Panel Training

Panelists were required to complete advanced training modules online, through the Moodle platform, before attending the in-person event. Panelists received information on the following topics through the advanced training:

- characteristics of students who take the DLM assessments
- content of the DLM assessment system, including learning map models, EEs, domains and topics, and linkage levels
- a high-level introduction to three topics that would be covered in more detail during onsite training: the architecture, dimensionality, and format of the NGSS PEs; the principles of Universal Design for Learning; and the steps in the EE writing and revision processes
- expectations of panelists as EE writers, including the process for writing new EEs, the similar process of editing existing EEs, how to reach consensus as a writing group, and using criteria for determining content and accessibility alignment for each EE
- continual checking of alignment of EEs to those EEs in grade levels before and after for horizontal alignment and a logical progression of science concepts through the grade levels
- continual checking of alignment of EEs to the intended focus of the NGSS bundles or themes

Panelists received additional training during the expansion and revision event to (a) review important advanced training concepts, (b) provide an in-depth explanation of the architecture and format of the NGSS PEs, including the dimensions that comprise them, (c) describe the processes of writing new EEs and revising existing EEs, (d) guide the panelists through a

practice round, in which panelists engaged in the process of revising an existing EE, and (e) describe the panelist responsibilities during the event.

II.f.2.ii. Facilitator Training

Facilitation of the EE writing event was carefully designed with science content, population, adult learning, and peer review expertise in mind. Table facilitators were chosen based on their experience with DLM events, test development, instruction for students with the most significant cognitive disabilities, science content knowledge, and/or DLM state partner usage of the EEs. Fourteen table leads were selected and assigned to tables based on their past experience and their personal preferences for working with panelists at the elementary, middle or high school levels.

In addition, room leads floated between tables for support with additional science content knowledge, population expertise, or the DLM historical perspective of how the original science EEs were developed.

DLM facilitators attended a full-day in-person training prior to the event and a 1.5-hour remote refresher training closer to the event’s start to complete the following tasks:

- review the goals of, objectives of, and expected deliverables from the event
- review the online training completed by all panelists
- develop deeper understanding of the architecture and format of the NGSS PEs
- describe the writing and revision processes and the resources which panelists would employ
- lead facilitators through the EE writing process that panelists would employ
- review and discuss effective facilitation strategies for reaching group consensus and for keeping the process moving forward
- share and discuss interventions to employ when panelists are stuck or disagree

II.f.3. Panel Assignments

Panelists were assigned to panel groups (three to four per group) according to their reported expertise in and experience within a grade level or band, general or special education student populations, and/or a science domain. Within each panel group, one to two panelists served in the role of science content experts and one to two panelists served in the role of accessibility experts. Furthermore, each group was assigned between 3 to 4 NGSS PE bundles, each containing 10 to 19 specific PEs, to write new DLM science EEs or to revise existing ones (Table 7 and Note. NGSS = Next Generation Science Standards; EE = Essential Element.

Table 8). We considered panelist preferences for science domains and their teaching experiences in their assignment to tables and bundles for the MS and HS groups.

Table 7. *Elementary Writing and Revising Assignments per Panel Group*

Group	Assigned NGSS PE bundles	Creation of new DLM EEs	Review/ revision of existing DLM EEs	Total assigned NGSS PEs	No. of panelists serving in content role	No. of panelists serving in accessibility role
K	3	11	0	11	1	2
1	4	10	0	10	2	2

2	3	12	0	12	2	2
3	4	15	0	15	2	2
4	3	14	0	14	2	2
5	3	7	9	16	2	2

Note. NGSS = Next Generation Science Standards; EE = Essential Element.

Table 8. *Middle and High School Writing and Revising Assignments by Panel Group*

Group	Assigned NGSS PE bundles	Creation of new DLM EEs	Review/revision of existing DLM EEs	Total assigned NGSS PEs	No. of panelists serving in content role	No. of panelists serving in accessibility role
MS – A	3	10	5	15	2	2
MS – B	4	12	3	15	2	2
MS – C	3	11	4	15	2	2
MS – D	3	12	2	14	2	2
HS – A	4	15	2	17	2	1
HS – B	3	14	4	18	2	2
HS – C	4	14	3	17	2	1
HS – D	4	8	11	19	2	2

Note. NGSS = Next Generation Science Standards; EE = Essential Element; MS = middle school; HS = high school.

II.f.4. Materials

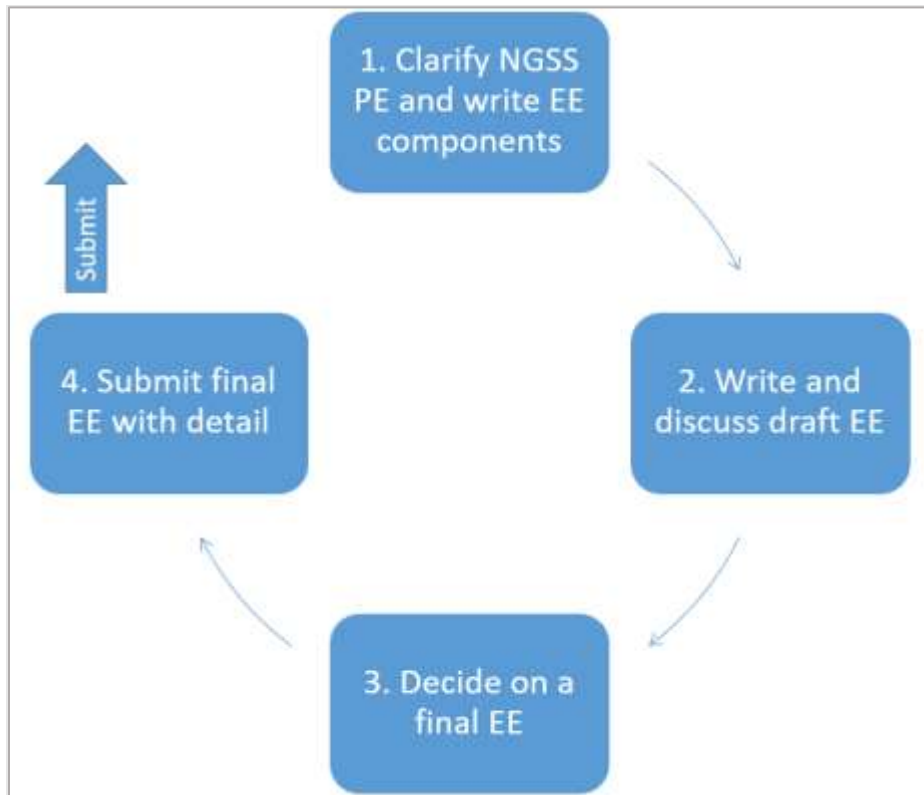
DLM facilitators provided each panel group access to the following resources and materials:

- Essential Element submission template
- *A Framework for K-12 Science Education* (NRC, 2012)
- *NSTA Quick-Reference Guides to the NGSS* (Willard, 2015)
- *Atlas of science literacy, Volume 1* (American Association for the Advancement of Science, 2001)
- *Atlas of science literacy, Volume 2* (American Association for the Advancement of Science, 2007)
- NGSS Matrices: CCCs, SEPs, and DCIs
- NGSS Progressions: CCCs, SEPs, and DCIs
- *Vocabulary for the New Science Standards* (Marzano et al., 2014)
- PBS KIDS Science Learning Framework (Brenneman et al., 2018)
- Common Core Standards for Mathematical Practice (Common Core State Standards Initiative, 2010b)
- Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects (Common Core State Standards Initiative, 2010a)
- DLM ELA and Mathematics Essential Elements
- DLM Adapted Science and Engineering Practices (SEPs)
- DLM Core Vocabulary
- DLM Foundation Nodes Detail

II.f.5 Developing Essential Elements

The panelists followed a four-step process for drafting new DLM science EEs (Figure 2). The process allowed time for panelists to individually process complex information, as well as for each group to respond to questions posed by the facilitator, seek clarification when needed, and reach agreement concerning drafting decisions. Panelists used the same process to revise existing EEs. We describe both procedures in this section.

Figure 2. *Four-Step Writing Process*



In the first step, panelists used the references described in section II.f.4. Materials to gain a foundational understanding of each assigned NGSS PE, including all three of its dimensions and its connections to other standards across English language arts, math, and science. Panelists used a guiding form (Form A; Figure 3), to help construct their foundational understanding of each assigned PE.

Figure 3. Form A With Resources and Guiding Questions

NGSS PE:		
DLM EE:		
<p>Science and Engineering Practice (SEP)</p> <p><u>Refer to:</u></p> <ul style="list-style-type: none"> • DLM Adapted SEPs • PBS Ready to Learn Framework • Matrix – SEPs in NGSS <p><u>Ask:</u></p> <ul style="list-style-type: none"> • What does it mean to do the practice? • What are the essential components of this practice? • What possible intersections might there be with other practices? 	<p>Disciplinary Core Idea (DCI)</p> <p><u>Refer to:</u></p> <ul style="list-style-type: none"> • Marzano Vocabulary Resource • PBS Ready to Learn Framework • Matrix – DCIs in the NGSS <p><u>Ask:</u></p> <ul style="list-style-type: none"> • What is the intended meaning of elements of the core idea? • Is there one idea or several separate ones in the statement? • What terminology is explicitly used in the core idea? • What peripheral ideas or terms are <i>not essential</i> for understanding the core idea? • Are there any commonly-held ideas that differ in important ways from the scientifically accepted understanding? 	<p>Crosscutting Concept (CCC)</p> <p><u>Refer to:</u></p> <ul style="list-style-type: none"> • PBS Ready to Learn Framework • Matrix - Crosscutting Concepts <p><u>Ask:</u></p> <ul style="list-style-type: none"> • What are the key aspects of this CCC? • What explanatory value does this CCC have? • What SEPs or DCI concepts provide unforced and meaningful connections with this CCC? <hr/> <p>Engineering (ETS) Nature of Science</p> <p><u>Refer to:</u></p> <ul style="list-style-type: none"> • PBS Ready to Learn Framework • Matrix – Engineering Applications • Matrix – Nature of Science Connections • Matrix – DCIs in NGSS, p 14
<p>DLM ELA EEs</p> <p><u>Refer to:</u> DLM ELA Essential Elements Document</p> <p><u>Ask:</u> Are there other DLM ELA Essential Elements (in addition to the ones listed in NGSS) that align and prop up these science concepts?</p> <p>DLM Mathematics EEs</p> <p><u>Refer to:</u> DLM Mathematics Essential Elements; Standards for Mathematical Practice</p> <p><u>Ask:</u> Are there other DLM mathematics Essential Elements (in addition to the ones listed in NGSS) that align and prop up these science concepts?]</p>		

In the next step, panelists used specific criteria (refer to section II.d. EE Development and Revision Criteria) to write a first draft of the EE, either individually or in pairs, considering their collective understanding of the three dimensions and connections across standards. Facilitators projected each draft EE on a screen at the panelists’ table.

In the third step, panelists reached agreement upon the final EE to submit based on the provided resources, discussions among the panelists, iterations of the EE, and collective agreement that the EE criteria were successfully met.

To submit the final EE, each panelist in a group completed a section of a template (Figure 4. *Sections of the Final EE Submission Template*), which correlated to a specific component of the final EE, such as the EE text itself, the science and engineering practice, disciplinary core idea,

crosscutting concept, and connections to English language arts and mathematics standards. After the groups completed each section, the facilitator checked each section and added an explanation of the group’s process and rationales that contributed to the final EE in effort to provide information that might be helpful for future interpretation or research.

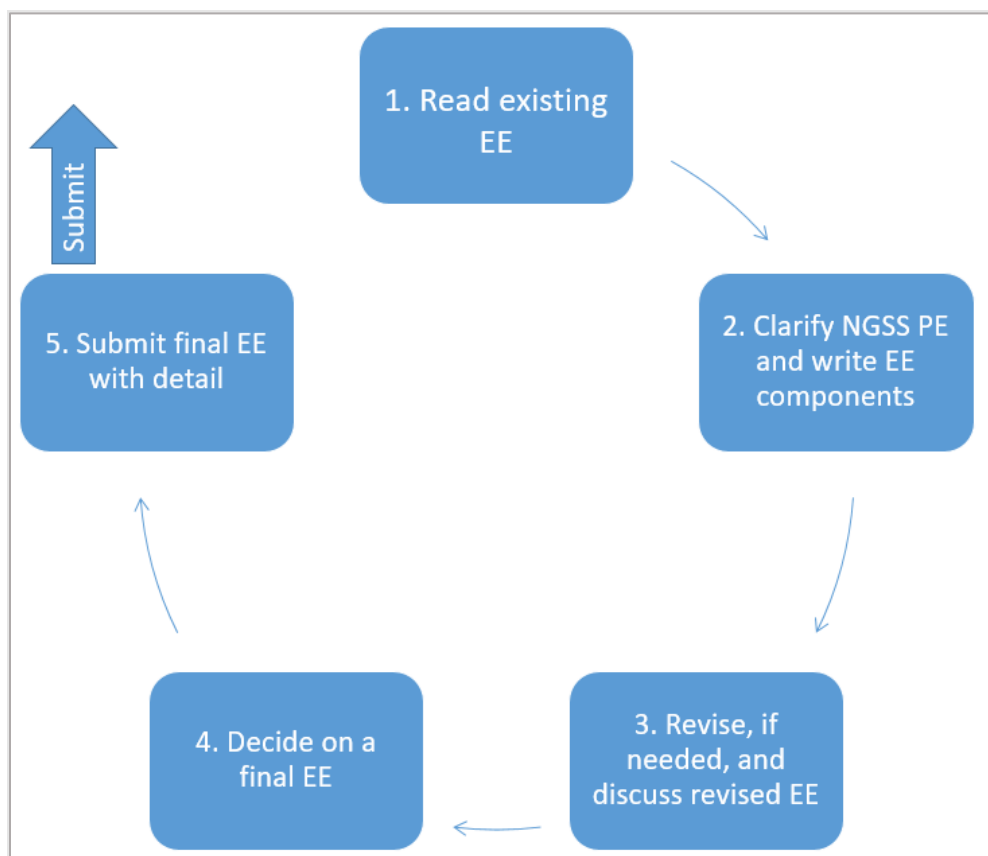
Figure 4. *Sections of the Final EE Submission Template*

Final Essential Element Submission (Form B)	
Panelist Name(s): _____	NGSS Standard Code: _____
Component (circle):	
<ul style="list-style-type: none">• Essential Element• SEP• DCI• CCC	<ul style="list-style-type: none">• Nature of Science/ETS• DLM ELA EEs• DLM Mathematics EEs• Rationale/Explanation
Enter component text here:	

II.f.5.i. Review of Existing Essential Elements

In addition to drafting new EEs, we designed a process for panels to review all of the existing DLM science EEs (43 total) for strong alignment to the three dimensions of the corresponding NGSS PE: its DCI, its SEP, and its CCC. This process only applied to grades 5, middle school, and high school, since no EEs had been previously developed for grades K–4. We assigned the existing to the same panel groups, by grade and focus, that drafted new EEs.

Figure 5. *Process for Review and Revision of Existing DLM Science Essential Elements (EEs)*



The process for reviewing and revising existing DLM science EEs was very similar to the process for writing new DLM science EEs (refer to section II.f.5). The only difference between the two processes was that an existing EE provided a starting point for drafting, discussing, and reaching agreement upon the final EE to submit.

As a part of the review of existing standards, the appropriate panels reviewed and revised the five EEs that were flagged for partial misalignment in the 2017 external alignment study. Panelists used the same review and revision process they used for all other existing EEs, except that panelists reviewing the flagged EEs had detailed information about the original panel findings (Nemeth & Purl, 2017), feedback from a follow-up panel review (Davidson, 2020), and recommendations from DLM staff to inform their work.

II.f.5.ii. Drafting and Revising Essential Elements

Panel groups used the available resources to draft new DLM EEs and revise existing ones according to the overarching science concepts, themes, or questions, upon which the NGSS PEs were bundled and assigned. Therefore, each group had the freedom to decide the order in which they addressed each PE, whether it required drafting a new EE or revising an existing one. On the last day of the event, panelists reviewed and edited the EEs they wrote over the three days.

II.g. Results

As a result of the 3-day event, panelists drafted 165 new DLM science EEs and reviewed and revised the 43 existing DLM science EEs (including the five previously flagged for alignment), using a process designed to strongly align the EEs to the NGSS and robustly connect the EEs to other ELA, mathematics, and science standards. This brought the total number of EEs to 208, which represents 100% coverage of the Next Generation Science Standards. Table 9 shows the drafts produced of new and revised EEs.

Table 9. *Results of DLM Science EE Expansion and Revision Event*

	Grade band			Overall
	Elementary	Middle school	High school	
NGSS PEs	78	59	71	208
Edited DLM science EEs	9	14	20	43
New written DLM science EEs	69	45	51	165
Coverage of NGSS	100%	100%	100%	100%

Note. NGSS = Next Generation Science Standards; PE = Performance Expectation.

The five EEs previously flagged in an external alignment study are included in the totals shown in Table 9. The panelists proposed revisions for those five EEs that directly address the alignment issues described in the external studies (Nemeth & Purl, 2017; Davidson, 2020).

II.g.1. Evaluation of the Panel Process by DLM Technical Advisory Committee Member

The chair of the DLM Technical Advisory Committee (TAC), Edward Roeber, was invited to attend the event and provide feedback on the design and implementation of the EE writing and revision processes. For two to four hours per group, he observed the collaborative work of four panel groups: a high school group, an elementary group focused on grade 2, a middle school (grades 6–8) group, and an elementary group focused on grade 5. Dr. Roeber observed the groups in the order listed, observing each group during a different stage of the development work. The high school group was first, and he observed them during the beginning stages of the process as they were developing understanding of and comfort with the writing and revision processes, locating the necessary and relevant resources, and ascertaining how to use them to create or edit EEs for standards. The second group Dr. Roeber observed, the grade 2 group, was engaged in revising a newly created EE and documenting how student proficiency of the EE could be observed. The third group, a middle school group, was finalizing the creation of a new EE and spent a significant portion of time reviewing alignment to the DCI, SEP, and the CCC. The last group, the grade 5 group, was finalizing their created and edited EEs by determining how student proficiency could be observed for each EE.

While the observations happened at different points in time, Dr. Roeber observed that each table operated in a similar fashion and worked from the same provided resources. Toward the end of the event, he observed that all tables were able to go through their drafted EEs a second time, revising the EEs for clarity and consistency. At the end of the event, Dr. Roeber reported that all groups had successfully written new or edited existing DLM EEs, producing a total of

208 EEs. Additionally, he reported that the design and implementation of the writing and revision processes will likely lead to the development of a set of robust and high-quality EEs. Overall, Dr. Roeber believes the panelists' work will greatly improve science instruction and science assessment for students participating in DLM science assessments. The text of the TAC member observation report can be found in Appendix A: DLM .

II.g.2. Evaluation of the Event Processes by Panelists

Of the 52 participating panelists, all but one responded to an evaluation questionnaire assessing the effectiveness of the training they completed, the effectiveness of the writing and revision processes they employed, and the quality of the event itself.

Table 10. Panelists' Responses About Effectiveness of Training, , and Table 12 provide summaries of panelists' responses to the questionnaire. As part of responses to short answer questions, panelists described the event as content-focused, collaborative, active, supportive, and introspective and reflective. One panelist noted, "I mentioned to others that I feel that this process was very productive and would work (in miniature) as a solid professional development model for teachers who are learning about EEs and the standards in general. This productive struggle provides an opportunity for understanding that just doesn't come from being "given" a final product."

Table 10. *Panelists' Responses About Effectiveness of Training*

	Very effective	Somewhat effective	Not effective
Online advance training	34	17	Ns
Onsite training	44	7	Ns
Onsite practice round	35	16	Ns

Note. Ns = Not selected

Table 11. *Panelists' Responses About Effectiveness of Event Processes*

	Very effective	Somewhat effective	Not effective
Facilitator feedback	48	3	Ns
Discussions within panel group	50	1	Ns
Discussion across panel groups	50	1	Ns
Onsite resources	47	4	Ns

Note. Ns = Not selected

Table 12. *Panelists' Event Feedback Survey Results*

	Strongly agree	Agree	Disagree	Strongly disagree	Not applicable
The overall objectives and goals were met.	43	3	4	0	1
I am confident that I applied the criteria for my review type.	37	8	0	4	2
My panel drafted Essential Elements aligned to the standards and meeting criteria.	44	1	0	4	2
My table facilitator was effective at guiding panelists through the process.	42	3	0	4	2
Overall, I valued the DLM Science Essential Element Expansion and Revision process as a professional development experience.	45	0	0	4	2

III. Future External Review Panel and Process Design

This section briefly describes the plans for the process and time frame of a future review event in which the drafted versions of the 208 DLM science EEs will be externally reviewed and finalized for consortium-wide use.

III.a. Statement of Goals and Purpose

To meet the priority established by DLM partner states, the primary goal of DLM EE expansion and revision is a complete set of EEs representing 100% coverage of the NGSS at a reduced level of depth, breadth, and complexity.

III.b. Anticipated Process

Approximately 30 panelists will be needed to review the draft EEs. DLM staff will recruit panelists for this expert review from DLM states. Panels will include both general and special education experts. Around 10 panelists will be assigned to each grade band (elementary: K–5; middle school: 6–8; high school: 9–12.) There will be two panels per grade band. Each of the panels will be composed of a mix of five panelists who are either content or accessibility experts. External reviews will be conducted remotely due to constraints surrounding COVID-19, following procedures developed in spring 2020 for other panel events that shifted to virtual models in response to the pandemic. Each external review panel will be facilitated by at least one DLM staff member, with the intent of arriving at an agreement between panelists concerning the final EE. Each panel will review between 30 and 40 DLM science EEs.

Facilitators will guide panelists through applying a set of fidelity criteria to the proposed EEs. Facilitators will present each panel with the original NGSS PEs alongside the most recent version of the EE—the revisions recommended by DLM staff during their internal review of the 208 EEs conducted via a digital form during the summer of 2020. Any standards that fail to meet a fidelity criterion will be recorded by the facilitator, along with the panel's revisions to the language of the final EE.

DLM staff are developing a final set of fidelity criteria to provide a uniform set of expectations for all final EEs that ensure every EE satisfies fundamental content and accessibility guidelines. The set of fidelity criteria will include considerations such as (a) strong alignment of each EE to its corresponding NGSS PE, including its three dimensions (science and engineering practices, disciplinary core ideas, and crosscutting concepts); and (b), and the incorporation of accessibility and fairness components that are appropriate for the DLM student population. The full set of fidelity criteria used for external review will be included in the final report.

III.c. Anticipated Timeline for Results

Panel review of the 208 DLM science EEs will occur in spring 2021. Upon completion of the separate panel reviews, a group of panelists from across the separate panels will conduct a broad analysis of all EEs to ensure proper articulation of standards from kindergarten through high school. This work will be performed by panelists who are familiar with aligning standards vertically (between grades) and horizontally (within a grade), ensuring a logical and grade-appropriate progression of skills. We anticipate that the development stage of the DLM science EEs will end by December 2021, followed by a consortium-wide review and acceptance of the EEs in 2022.

References

- Achieve. (n.d.). *Disciplinary core idea*. <https://www.nextgenscience.org/glossary/disciplinary-core-idea-dci>
- Achieve. (2016). *Example bundles guide*. <https://www.nextgenscience.org/sites/default/files/Example%20Bundles%20Guide.pdf>
- American Association for the Advancement of Science. (2001). *Atlas of science literacy, Vol. 1*. Project 2061.
- American Association for the Advancement of Science. (2007). *Atlas of science literacy, Vol. 2*. Project 2061.
- Brenneman, K., Brown, B., Sweetman, S., Worth, K., CAST, Conn-Powers, M., & Retamal, F. (2018). *PBS KIDS science learning framework*. Crystal City, VA: PBS KIDS. <https://www.cpb.org/file/5643/download?token=5eWOvvs6>
- Common Core State Standards Initiative. (2010). *Common Core State Standards for English language arts & literacy in history/social studies, science, and technical subjects*. http://www.corestandards.org/wp-content/uploads/ELA_Standards1.pdf
- Common Core State Standards Initiative. (2010). *Common Core State Standards for mathematics*. http://www.corestandards.org/wp-content/uploads/Math_Standards1.pdf
- Common Core State Standards Initiative. (2012). *K-8 publishers' criteria for the Common Core State Standards for mathematics*. http://www.corestandards.org/assets/Math_Publishers_Criteria_K-8_Summer%202012_FINAL.pdf
- Common Core State Standards Initiative. (2013). *High school publishers' criteria for the Common Core State Standards for mathematics*. http://www.corestandards.org/assets/Math_Publishers_Criteria_HS_Spring%202013_FINAL.pdf
- Davidson, A. H. (2020). *Dynamic Learning Maps science alignment follow-up study*. EdMetric.
- Dynamic Learning Maps. (2016). *DLM adapted science and engineering practices*. https://ca1.qualtrics.com/CP/File.php?F=F_7QFfZNSHO9U6YyV
- Dynamic Learning Maps Science Consortium. (2015). *Dynamic Learning Maps Essential Elements for science*. University of Kansas, ATLAS. https://dynamiclearningmaps.org/sites/default/files/documents/Science/Science_EEs_Combined.pdf
- Jin, H., Mikeska, J. N., Hokayem, H., & Mavronikolas, E. (2019). Toward coherence in curriculum, instruction, and assessment: A review of learning progression literature. *Science Education*, 103(5), 1206–1234. <https://doi.org/10.1002/sce.21525>
- Lee, O., Miller, E., & Januszyk, R. (2014). Next Generation Science Standards: All standards, all students. *Journal of Science Teacher Education*, 25(2), 223–233. <https://doi.org/10.1007/s10972-014-9379-y>
- Marzano, R. J., Rogers, K., & Simms, J. A. (2014). *Vocabulary for the new science standards*. Marzano Research.

- Nash, B., & Bechard, S. (2016). *Summary of the science Dynamic Learning Maps® alternate assessment development process* (Technical Report No. 16-02). University of Kansas, Center for Educational Testing and Evaluation.
https://dynamiclearningmaps.org/sites/default/files/documents/publication/Summary_of_the_Science_Development_Process_revised.pdf
- National Research Council. (2007). *Taking science to school: Learning and teaching science in grades K-8*. The National Academies Press. <https://doi.org/10.17226/11625>
- National Research Council. (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas*. The National Academies Press.
<https://doi.org/10.17226/13165>
- National Research Council. (2013). *Next Generation Science Standards: For states, by states*. The National Academies Press. <https://doi.org/10.17226/18290>
- Nemeth, Y., & Purl, J. (2017). *Dynamic Learning Maps science alternate assessment—Alignment study* (Report No. 009). Human Resources Research Organization (HumRRO).
- Willard, T. (2015). *The NSTA quick-reference guides to the NGSS, K-12*. National Science Teachers Association Press.

Appendix A: DLM TAC Member Observation Report

Edward Roeber

Chair, DLM Technical Advisory Committee

November 2019

As chair of the DLM Technical Advisory Committee, I was invited to attend as an observer at the meeting to create or edit Target Essential Elements (EEs) for use in the revised DLM science assessment to be based on the Next Generation Science Standards (NGSS). I was asked to observe group and individual attendee engagement with the process, and use the following questions as a guide for providing feedback about the meeting and the work accomplished during it.

1. To what extent did the *intended* EE writing/editing process foster DLM Consortium members' sharing of expertise?
2. To what extent did you observe that the *actual* EE writing/editing process will lead to a robust set of new DLM science EEs?
3. To what extent were the table panelists engaged with the process? As individuals? Within small groups? During large group activities?
4. To what extent did you observe that table facilitators were leading the process in a professional and informed manner? In a manner that established trust and encouraged table panelists to share expertise equally?
5. To what extent did you observe that DLM staff were supporting the effort to produce a robust set of new DLM science EEs (i.e., the Lead Facilitator, Science and Accessibility SMEs, Implementation Team members, other DLM staff and leadership supporting the event)?
6. Add any general observations or comments about the DLM science EE writing/editing event that you feel will be helpful or informative to the process or to future conversations.

I was asked to observe the meeting in its entirety, which I did, and to prepare a report of my observations. It is intended that these observations assist DLM staff and member states in future governance, conformance checks, or research activity. It was anticipated that this report might also be included in a future technical or other report on the development of the revised DLM science assessment.

Introduction

This activity consisted of 52 panelists, who worked in 14 tables of 3–5 individuals per table, plus 30 staff, who served as room lead, 14 table facilitators, one content specialist, one accessibility specialist, two science subject-matter specialists, several others who floated around the room, two data entry specialists, and two meeting support staff.

Participating content specialists and accessibility were selected from a database maintained by the ATLAS implementation team of past and potential attendees for various DLM functions. This includes state and local educators drawn from all 20 DLM states. The database contains a variety of demographic and other information, such as place and nature of employment, about potential attendees. This permitted DLM to select a representative group of experts to serve as

panelists for this meeting. The goal was to recruit a diverse group of panelists that represented member states.

DLM sought to recruit 24 elementary educators, 16 middle school educators, and 16 high school educators, with about an equal number of special educators and general educators. There also was a goal to mix science expertise among the several domains of science: earth & space science; life science; and physical science at the middle school and high school levels.

Attendees were required to complete advance training modules using Moodle as a platform. The modules included an introduction to the DLM system (i.e., maps, linkage levels, and EE content); an introduction to NGSS and the three dimensions contained in them; and an introduction to the EE writing/editing process. Facilitators attended a full-day training and a 1.5-hour refresher training prior to the event in order to orientate them to their role, the NGSS standards for which their group would be responsible, the resource that would be available for their table to use, and the outcome expected from each group.

I arrived at the meeting without any prior orientation or training such as required of meeting attendees or facilitators. While I was familiar with the DLM model and NGSS and had a general idea of the work to be done, I was not familiar with the details of the process or the resources available for attendees. This meant that I needed to learn these details quite quickly so as to “catch up” to the attendees and facilitators.

I was able to sit with four tables of subject-matter and accessibility experts for between two to four hours per table as they worked to create or edit the Target EEs for each NGSS. A total of 14 tables were used during the meeting. These included single tables for grade K–5 and four tables each for middle school and high school. Each table had a DLM facilitator/recorder and between 3 to 6 science experts and accessibility experts.

Each table was given between 10 and 19 NGSS for which either new EEs were to be written or existing EEs were to be edited as necessary. Panelists were instructed to capture as much of the original NGSS as possible so as to permit students with significant intellectual disabilities to fully participate in the DLM science assessment. By writing or editing high-quality science EEs aligned to the three dimensions of the NGSS, the goal was that they will serve as the backbone to future science learning maps, instructional resources, and DLM assessments.

The four tables observed included a high school table, a grade 2 table, a middle school (grade 6–8) table, and a grade 5 table. Tables were observed in this order. The work was similar in each group. Each team was provided a list of standards that corresponded to bundles that the authors of the NGSS had previously developed. NGSS describes these bundles as they are: “. . . groups of standards arranged together to create the endpoints for units of instruction ‘Bundling’ is an important strategy for implementing the standards because (creates) connections between concepts and brings coherence to classroom instruction.”

The work of each group consisted of review of any previously-written EEs for some of the NGSS at grade 5 through HS, while all-new EEs were needed for the standards at grades K–4. EEs had been written for a few of the middle school and high school standards assigned to the groups observed; each group was asked to review this work and either concur with or edit these EEs. All existing EEs were also examined in terms of alignment to the three dimensions outlined in the NGSS. Previous versions of DLM science EEs were not written to align to the crosscutting concept dimension: this writing event added that language to existing standards. The other two

dimensions were updated and connections to DLM mathematics and ELA EEs were reviewed and improved.

In grades K–4, no EEs had been developed for any of the standards so those work groups needed to do this work from scratch.

Because of the time when I joined each table (Day 1 afternoon, Day 2 morning and afternoon, and Day 3 morning), I observed that each group was at a different stage in the development work. The high school team I sat with was just getting started, so I observed them becoming comfortable with the process, locating the necessary resource, and then using them to create EEs for standards or to edit existing ones. The grade 2 team that I sat with was completing its assignments and had moved to editing and adding to the Excel chart that more fully described how student performance on each EE could be observed. The middle school team was finishing its work of creating EEs for the NGSS assigned to it, but they also reviewed the DCIs, SEPs, and CCCs. I observed their work in doing so. I completed my observations by sitting with the grade 5 team on Day 3 morning. This group was completing its work on creating EEs for NGSS, and then they went through all EEs to determine how student performance could be observed.

By the end of Day 3, all groups had successfully written new or edited existing DLM EEs from every NGSS (for a total of 208). All groups had also successfully completed a second iteration of edits, reading back through each EE they had written and edited the statements for clarity or closer alignment. All elementary (K–5) groups, two of the four MS groups and one of four of the HS groups were also able to go through their lists of EEs a third time in order to write "Evidence Statements," or classroom observations that would indicate student learning of each EE. In addition, groups that completed their work early were able to check on cross-grade progressions of standards to begin to read and edit the EEs written by other groups.

Responses to the six questions posed for observer response are provided below.

1. To what extent did the *intended* EE writing/editing process foster DLM Consortium members' sharing of expertise?

I sat with and observed the process used in each of four groups for two or more hours per group. The meeting design was for two pairs of science and accessibility experts (with one of each type of expertise) to carry out the work in parallel in each group to work in creating each EE for the same NGSS. I observed this is the high school group, at least initially. After creating EEs for a couple of NGSS, the two pairs of experts fell into a full group discussion for a couple of EEs. This started when each pair of experts reported out to each other, and then the four experts discussed the final proposed wording of the EE. When meeting as a whole group, three of the four participants actively participated and the fourth observed and listened, without comment.

Subsequently, the four experts took on a couple of new EEs by working together. This continued until they disagreed, at which time they returned to two parallel groups.

The grade 2 group had only three experts (one science and two accessibility experts) and met as an entire group only, with all participating equally. This team did use a "divide and conquer" approach, with group members, after individually suggesting EE wording and then coming to an agreement on the wording of the extended standard, each member taking either the SEP, DCI, CCC, or Engineering, and Nature of Science content in the NGSS and suggesting any edits to these, along with which DLM ELA or mathematics EEs that fit with

the DLM science EE as written by the group. These were collected by the facilitator without review by other panelists.

The middle school team met as an entire team, but this may have more to do with when I joined the group, because the group had completed its work in writing or editing EEs. The task observed was to write a description of how each EE could be observed.

The grade 5 team also mostly operated as an entire group. Again, the nature of the task might have explained why the group worked together. One member only participated sporadically, choosing instead to look at messages on her cell phone (something not commented on by the facilitator).

Each of these approaches was functional and led each group to carrying out its assigned work efficiently. Other than the high school group, however, I did not review the wording of the EEs after they were developed or edited.

2. To what extent did you observe that the *actual* EE writing/editing process will lead to a robust set of new DLM science Essential Elements?

As an individual who had worked directly for several states as they expanded state content standards in disciplines such as ELA, mathematics, science, and social studies for an organization for which I worked previously, I was quite interested in how this process would be the same as or different than what I had previously experienced 15–20 years ago. I was especially listening for statements that the target group of students—students with significant intellectual disabilities—would be unable to access most or even any aspect of one or more NGSS.

Not once in the discussions I participated in—at grades 2 and 5, middle school, and high school—did I hear this. There were no NGSS that any group deemed too difficult and therefore could not be expanded. I did hear about challenging NGSS that might have presented challenges in extending that other grade-level groups had encountered, but I did not hear this directly from groups assigned those standards. Thus, I believe that the Target EEs written by the four groups I observed “will lead to a robust set of new DLM science Essential Elements.” I observed all participants trying to write extended EEs that are rigorous and yet attainable by at least some of the target students.

3. To what extent were the table panelists engaged with the process? As individuals? Within small groups? During large group activities?

I observed that panelists in the four groups were all engaged in the process, most quite deeply (with one exception noted above). In the high school group, observed as the group began its work on day 1, one accessibility specialist dominated the discussion about how students with disabilities could access the standard, and the other accessibility specialist tended to sit back and not say anything. As noted above, this group started as two pairs working in parallel, but morphed into one large group when discussing their independent work in the creating new EEs. Then this group started working on additional standards as a full group of four (with one accessibility specialist listening much more than contributing). The group was able to accomplish the work assigned to it, and as noted by the project facilitator, was the first to complete writing or editing all of the high school standards assigned to it.

In the other three groups, the experts participated as a single group, and all individuals contributed to the robust discussion of each part of the task. Each group also spent some time silently pondering the potential wording of the EEs, which I think led to a feeling that they were taking the time to carefully consider the wording of each EE.

Although the observer joined the four groups at different times on different event days, the content of the discussion was nonetheless thorough. All groups worked comfortably together and all achieved the work assigned to them, plus additional tasks.

4. To what extent did you observe that table facilitators were leading the process in a professional and informed manner? In a manner that established trust and encouraged table panelists to share expertise equally?

Each table facilitator was clearly in charge of their group and led the group in a professional manner. They kept the work flowing without rushing anyone, pausing for group members to contribute, and when there were different potential wordings of an extended standards, kept the different alternatives before the group so that they could decide as a group what wording they preferred. The third and fourth groups I observed used a LCD projector, with the facilitator typing in different wordings. The grade 2 facilitator even showed alternative EE wordings, which I felt was especially helpful for this group to consider when considering which choice of words and wording made sense to them. Each facilitator also made sure the EE criteria for each EE drafted were reviewed (item by item) to assure that all of the EEs that were written or edited met all aspects of a useful EE.

5. To what extent did you observe that DLM staff were supporting the effort to produce a robust set of new DLM science EEs (i.e., the Lead Facilitator, Science and Accessibility SMEs, Implementation Team members, other DLM staff and leadership supporting the event)?

DLM staff circulated throughout the room during the entire time I was sitting with groups. (At one point during the afternoon of Day 2, I wondered how many hours each DLM staff member had been on their feet, since it seemed to have been all day.) I did not see many questions or issues that arose for which the group facilitators needed to provide assistance, but I did observe the Lead Facilitator, Science and Accessibility SMEs, Implementation Team members, other DLM staff at different locations in the room, occasionally meeting with a group in obvious discussion of some point raised by that group.

Runners collected envelopes of the work of creating or editing EEs for each NGSS, and the work of each group was entered into the master Excel chart soon after each group completed its work in creating or editing its EEs. This assured that the Excel file was available for groups to view so that they could reread their work as well as read the work of other groups, helping to assure that the EEs will progress in a logical manner between grade levels.

6. Please add any general observations or comments about the DLM science EE writing/editing event that you feel will be helpful or informative to the process or to future conversations.

What I observed was a comprehensive, well-planned activity, carried out extremely well with excellent overall facilitation and support. I believe participants will report that this was an interesting and informative process, with the science experts learning more about how

students with disabilities might access the NGSS, and the accessibility experts learning more about the science content and processes contained in the NGSS.

Panelists set the Target-level EEs for use in the DLM science assessment that will be combined with EEs for lower level access. I asked staff and a few participants about whether all five EE levels used for DLM ELA and mathematics assessments will be applied to the DLM science assessment, but was not given a clear answer to this question. This left me wondering what the final design and content will be for the next-generation DLM science assessment, and whether a similar process will need to be used to interpolate between existing DLM extended science standards and/or to extrapolate beyond the Target-level EEs set during this meeting.

Summary Observations

All of the groups that I sat with worked hard on the tasks asked of them. The room was loud with all of the discussion going on, which resulted in a headache for this observer on Day 2. Discussion was rich with how the students who would participate in the assessment could access each NGSS standard. Individuals worked hard to write EEs at aspirational yet attainable levels for the Target students. This observer did not hear any group state that some of the NGSS standards were simply beyond the reach of the students – that is, could not be extended to a level that they could access.

Both the Science and the Accessibility experts worked hard at the task. By the end of the meeting, each reported learning from one another. While there is considerable work ahead to turn these assessments into the revised DLM science assessment, this observer believes that the work of the combined science and accessibility experts has provided a sound basis for such work.

As a side note, participants also remarked about the benefits of working with colleagues and in learning more about the DLM project and how its assessments are created. Most wished there were additional opportunities to continue to be involved.

Suggestions for Improvement

Should DLM staff have the need to conduct a meeting such as this again, there are several ways that the process could be easier or more efficient. These are:

- A. Have fewer tables in one room to reduce attendee fatigue from excess noise and permit all participants in each group to be heard. It is hard to hear when 60 or so participants are all trying to talk over the noise of others' also talking.
- B. Use an LCD projector and computer for the work of each group to be projected for the group to see and comment on. This seemed to move the work of the grade team along.
- C. Have a screen—ideally an actual screen (or a larger piece of paper)—to project the work of the group for all to see. This could permit the facilitator to type draft text (and even alternative draft text) for the group to see and to make decisions. I saw this in grade 2 group on Day 2.
- D. Perhaps have the group facilitator enter the new or edited EE text into the final Excel spreadsheet. They appeared to be doing this for the suggested ways for students to be observed, but not for the EEs themselves. The rationale for hand-writing the new or edited EEs was not obvious to this observer.

- E. When there are multiple groups for a grade level or grade range, DLM staff might consider having one group review the new or edited draft EEs of another group. Typing the EEs into the final Excel spreadsheet might facilitate this cross-group review work.
- F. It would have been helpful for this observer if the materials for my use during the meeting had been provided before the meeting began so I could have walked through the material in each tab in the binder assigned to me so I could better understand how the DLM staff intended panelists to use them. I was not given the HS tab 4 materials until mid-afternoon of Day 1, and not provided the grade 2 materials until I had been in that group for some time. I did not receive the middle school or grade 5 tab 4 materials at all. Tab 4 is where the NGSS assigned to each group were listed, along with an indication of whether new Target EEs needed to be written, or existing Target EEs needed to be reviewed and edited. This observer had to “play catch-up” each day during the meeting.
- G. On a related note, I think it would have been helpful at the start of the meeting to walk all participant (including this observer) through the materials behind each tab. This apparently was a task assigned to each group facilitator, but this was not observed in the group that I began with. Many resources were provided, and it was my belief that DLM provided those so participants could use them in a predetermined order. However, it took each group some time to decide which resources were pertinent and which could be ignored. This is not necessarily a criticism of the processes used, because freedom was given to the facilitator to tailor the review of NGSS and writing/editing of EE processes to the members of their individual groups. It would have been helpful to orientate the observer to the process to access the NGSS and the binder materials that were to be used as the groups considered how to create or edit EEs. However, this observer may have been alone in having to figure this out on the fly at the start of the work, since this observer did not hear any complaints or negative comments from either the content or accessibility experts.

Note: Despite the relatively minor issues noted above, the groups convened by DLM staff achieved the intended work on time and with a depth of content coverage suitable both for the NGSS and the target group of students. When refined and used to create the revised DLM science assessment, the panelists’ work should greatly improve science instruction and science assessment for the students with disabilities who participate in the DLM science assessment.