

Los Angeles County Office of Education Performance Task Development Project: A Case Study

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Introduction

Over the past three decades, major education reform efforts in the United States have focused on teacher professional development (Choy et al., 2006; Hawley & Valli, 1999), which is considered essential for improving student learning. Schools have devoted resources, including funding and time, to a range of professional development programs (Killeen et al., 2002). However, as the number of academic improvement initiatives continues to grow, researchers have found that many of these programs are ineffective in supporting necessary changes in instruction to support these reforms (Darling-Hammond & McLaughlin, 2011; Garet et al., 2001; Yoon et al., 2007). As teachers are now implementing rigorous 21st-century standards, such as the Common Core State Standards and the Next Generation Science Standards (NGSS), they need effective professional development to help them implement high-quality standards-aligned instruction and assess how well their students are meeting the standards.

These academic standards call for a concomitant shift toward assessment that allows students to apply their learning and demonstrate their knowledge (McTighe & Wiggins, 2013). Performance assessment, which allows students to show what they know and can do by producing an original response, can measure a student's ability to apply content knowledge, reasoning, and communication skills to meaningful problems (Chung et al., 2010). Engaging educators in the development of authentic performance tasks can deepen their understanding of the academic standards and provide them with instructional strategies to support students. Performance tasks also help educators hone their ability to elicit and evaluate standards-aligned evidence of student learning.

To that end, in 2015, the Building Educator Assessment Literacy project (BEAL) at WestEd, in partnership with the Stanford Center for Assessment, Learning, and Equity (SCALE), worked with the Los Angeles County Office of Education (LACOE) to create the Performance Task Development Project (PTDP), a year-long, four-workshop professional learning series to support educators in writing and implementing standards-aligned performance tasks.

Specifically, LACOE requested support on how to facilitate understanding and coherence of performance assessment across 80 autonomous and diverse districts. With the adoption of the California Assessment of Student Performance and Progress system, which incorporates performance assessment to measure achievement on the California Common Core State Standards for English Language Arts and Mathematics and the California Next Generation Science Standards (CA NGSS), there was a need to help teachers make connections in their instruction between statewide assessments and standards. Out of this need, LACOE and its partners (SCALE and WestEd) created the PTDP.

This brief shares findings from an explanatory case study that examined the experiences of teachers, administrators, and staff in a district in LACOE that participated in a science cohort of the PTDP, from September 2018 to November 2019. The case study explored their perspectives about PTDP's impact on their instruction and on their understanding of performance task development and the NGSS. The goal of this case study was to document what teachers, administrators, and staff gained from their participation in the PTDP workshops and how that participation shifted their instructional practices. This study sheds light on potential promises and barriers to success that can inform future performance task development efforts.

Overview of the Performance Task Development Project

As defined by the PTDP, performance tasks are a collection of questions for students that lead to a culminating question and are coherently connected to a single theme or scenario. Performance tasks are meant to measure students' capacities, such as depth of understanding, complex analysis, and problem solving. Students are asked to understand data and apply them to an authentic situation to demonstrate their knowledge, skills, and abilities. Unlike a group of disparate selected-response items (e.g., multiple-choice or matching) in which students select from given options — and which do not require them to actively make meaning — a performance task presents a situation that calls for learners to apply their learning in context.

Described as a working workshop, the PTDP integrates content standards, targeted feedback, and hands-on workshops. The objectives of the PTDP are the following:

- Ensure Los Angeles County students experience standards-aligned, formative performance assessments
- Support Los Angeles County local education agencies in the creation and use of reliable formative performance assessments
- Build a regional network of performance assessment specialists
- Create a repository of performance assessments that may be accessed by districts within Los Angeles County
- Foster assessment reliability and coherence across Los Angeles County

Ultimately, the PTDP strives to support educators' efforts to gain a deeper understanding of academic standards, develop standards-aligned assessments, and incorporate performance assessments as part of a continuous improvement cycle to monitor and revise their instructional practices to support all of their students and prepare them to be college- and career-ready.

PTDP Science Workshop Series

While the PTDP was originally developed to help math teachers develop performance tasks related to the California Common Core State Standards, in 2018 the PTDP launched a science series to help teachers develop, administer, and score grade-level performance tasks related to the CA NGSS. To reach as many districts as possible, the PTDP Science Workshop Series was divided into two location-based groupings identified as Beach Cities and San Gabriel Valley for both Year 1 and Year 2 of the program. More than just a scoring calibration session, the training structure guided participants through the process of connecting what they learn about assessment design to their own instructional practices. Both the Year 1 and Year 2 Science Cohort participants attended a total of four workshops each. Table 1 summarizes the focus areas for each Science Cohort workshop.

Table 1. Focus of Each Workshop in the Performance Task Development Project Science Cohort Series

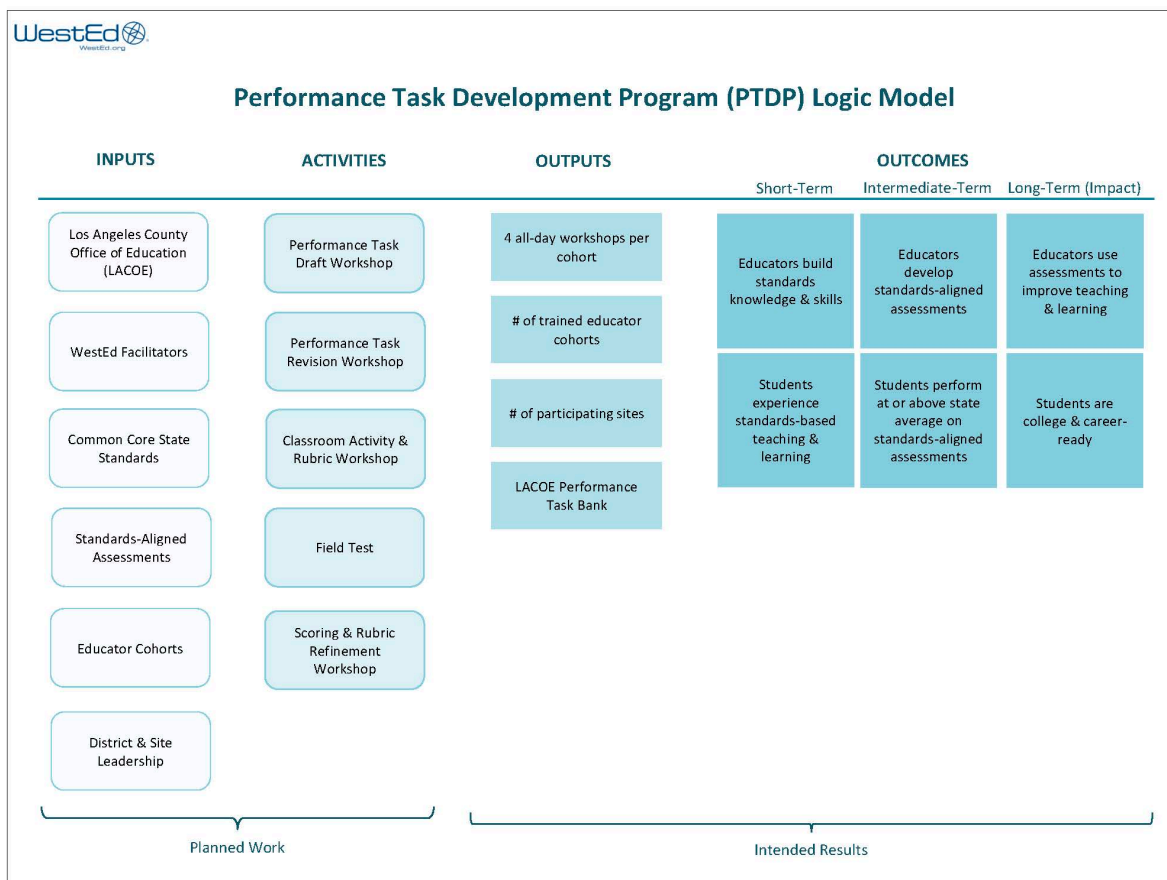
Workshop	Focus
Draft performance task	<ul style="list-style-type: none"> • Deepen understanding of standards • Deepen understanding of application and performance
Revise draft performance task	<ul style="list-style-type: none"> • Deepen understanding of equity and access • Deepen understanding of assessment claims and targets
Develop class activity and rubric design	<ul style="list-style-type: none"> • Define proficiency • Reflect on inquiry pedagogy
Score student work	<ul style="list-style-type: none"> • Refine scoring • Ensure student access and equity

During the first workshop, educators draft a performance task based on scientific phenomena, which are observable events that occur in the universe that prompt students to ask “what,” “how,” and “why” questions and use their knowledge and skills to make sense of them. To ensure that the task aligns with NGSS performance expectations, participants identify relevant NGSS concepts, including Performance Expectations and the three foundational dimensions: Science and Engineering Practices, Disciplinary

Core Ideas, and Crosscutting Concepts. During the second workshop, teachers exchange draft tasks with grade-band colleagues to review and reflect on them within the context of the California Science Test (CAST) format, in particular stimuli and item types. During the third workshop, educators create a class activity that prepares students to engage with the performance task by explaining vocabulary and concepts relevant to the task. They also finalize their performance task, including their scoring rubric, for field testing. For the last workshop, participants analyze student work from the performance task that was field tested, create anchor sets based on student work that characterize each score on a rubric scale, and refine their performance task. (See Appendix A for an example of a fully completed performance task generated from the PTDP Science Cohort workshop series.)

In combination, these four workshops provided educators with the opportunities and tools to understand the NGSS, develop relevant assessments connected to an NGSS performance expectation, collaborate with colleagues, and support all students. Figure 1 presents a logic model of the overall PTDP approach.

Figure 1. Performance Task Development Project Logic Model



Research Approach

To ensure a holistic approach to exploring the relationships, activities, and circumstances that contributed to the persistence and impact of the PTDP Year 2 Science Cohorts, LACOE and WestEd agreed that the WestEd research team would carry out a case study incorporating mixed methods of data collection. As “an empirical inquiry that investigates a contemporary phenomenon within its real-life context” (Yin, 1994, p. 13), a case study can describe, illuminate, and explain complex interventions, relationships, communities, or programs. This section presents the research question, case study participants, and methods for collecting and analyzing the case study data.

Research Question

Guided by the logic model, this study examined educators' experiences as a result of their participation in the PTDP Science Cohorts. Adopting a case study approach, the WestEd researchers asked respondents about their professional learning, what they gained through their engagement with the program, and how the program impacted teaching and learning at their site. Specifically, the research question was the following:

- How did the PTDP build educators' knowledge of the NGSS, facilitate their development of standards-aligned assessments, and influence their instructional practices to support students?

Case Study Focal District

At the request of LACOE, the research team looked for a district on which to focus the case study that had engaged in the PTDP program for an extended period of time. LACOE hoped to understand how one district, school site, and classroom interacted across levels to contribute to successful PTDP implementation. With guidance from the LACOE consultant, who oversaw PTDP training, the research team selected Rowland Schools.¹ In this district, the PDTP had flourished at one site, Alvarado Intermediate School, under the leadership of a particular teacher, referred to in this report as Ms. S, who had joined Year 1 of the PTDP Science Cohort and continued to attend workshops during Year 2 of the program with her colleagues from her school. Given her experience in the program and leadership role at her site, she introduced the WestEd researchers to three of her fellow science teachers who participated in Year 2. In addition to these science teachers, the team interviewed Alvarado Intermediate's principal and an instructional coach. At the district, the researchers spoke with the Director of Instruction Support and a science-content teacher on special assignment (TOSA).

Alvarado Intermediate School is one of two intermediate schools in the district serving seventh- and eighth-grade students. Total student enrollment is 737 students. Similar to the demographics of Alvarado Intermediate's district, 73 percent of students are socioeconomically disadvantaged, and 21 percent are homeless. Asians make up the largest student population at 42 percent, followed by Latinx (45 percent), Filipinx (6 percent), White (4 percent), and African American (1 percent). English learners represent 13 percent of the student population, which is lower than the district's English learner population of 24 percent. For the 2018–19 CAST, which was its first full administration, 47 percent of eighth graders at Alvarado Intermediate met or exceeded standard (level 3 or 4, respectively), compared with 31 percent for the district.

¹ For the purpose of this report, the authors use the term *Rowland Schools*, which is more commonly used by administrators, teachers, and staff, rather than by the Rowland Unified School District

Data Collection

Observations

Two members of the research team each attended and observed the last two of the four total Year 2 PTDP Science Cohort workshops, which focused on developing a class activity and rubric design (workshop three in September 2019) and scoring student work (workshop four in November 2019). Similar to the Year 1 Science Cohort, the Year 2 Science Cohort members were separated into two location-specific groupings. In Beach Cities, there were six participating districts, and in San Gabriel Valley, there were seven. Each district sent one to seven TOSAs. The majority of participants were teachers who taught either elementary or middle school. On average, 21 teachers and TOSAs attended Year 2 Science Cohort workshops. In general, teachers from the same site sat together to work on group activities, such as revising rubrics or share reflections. If participants did not have any colleagues in attendance, they were usually grouped by grade span to collaborate and exchange comments and suggestions. Observing the workshops allowed researchers to gather process data on the delivery of content and to observe participant engagement throughout the day.

WestEd researchers also conducted site visits at Alvarado Intermediate in January and February 2020. During the one-day visit in January, the researchers observed an eighth-grade honors science class and interviewed Ms. S and the three science teachers who participated in the Year 2 PTDP Science Cohort, as well as an instructional coach and the school's principal. During the second school visit, a research team member returned to the same class and observed a field test of the performance task class activity that the Alvarado Intermediate teachers developed after their participation in the PTDP Science Cohort workshops.

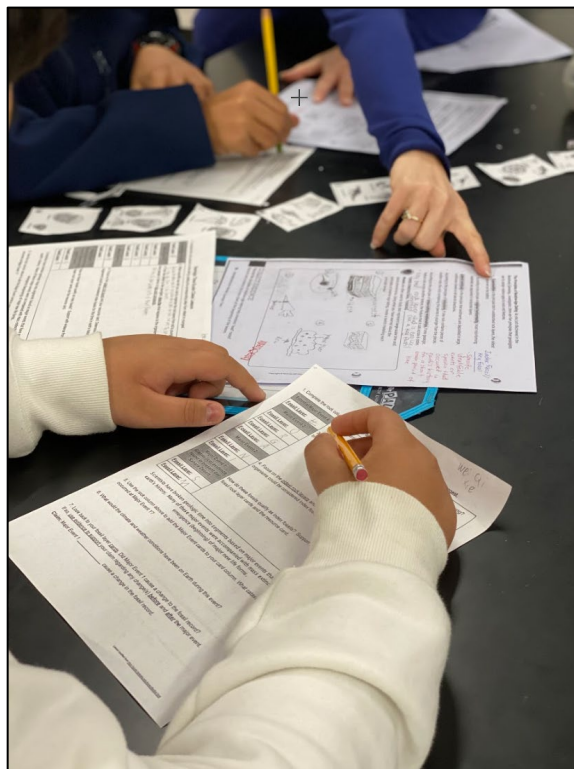


Figure 1. Students engaging in the class activity.



Figure 2. Ms. S reviewing the class activity with some of her students.

Interviews

Semi-structured interview protocols were designed for each category of interview respondents:

- Protocols for teachers explored their participation in the PTDP, perceived influences of the PTDP on their instructional practice, and challenges and successes they experienced engaging in and applying professional learning from the project.
- Protocols for administrators focused on their connection to the PTDP, their perspectives of teacher participation and related influences on instruction and collaboration, and challenges and successes related to the PTDP Science Cohort.
- Protocols for PTDP facilitators and staff from LACOE and WestEd asked about the history and purpose of the PTDP, perceived influences on participants' instructional practice, and challenges and successes they observed in the PTDP Science Cohort.

The interview protocols were designed to take approximately 45 minutes and were conducted online or in person. All interviews were audio recorded when possible, in addition to a team member taking detailed notes. At Rowland Schools, WestEd interviewed a district administrator and a TOSA. At Alvarado Intermediate, the team interviewed four science teachers, the science-content instructional coach, and the principal. In addition to the district and school participants, the team spoke with the LACOE administrator and contract consultant who managed the PTDP and the WestEd project director and facilitator who worked closely with LACOE on the PTDP to gain an understanding of the development of PTDP. (See Appendix B for interview protocol.)

Data Analysis

Qualitative analytic procedures for the study were designed to synthesize information pertinent to the research question. The research team consolidated PTDP workshop and classroom observations, along with interview notes, to develop a coding structure focused on emergent themes related to the participants' perceptions about the PTDP, including their experiences during the workshops and the project's impact on teaching and learning in their classrooms. As an additional step, the team used Dedoose, an online data management and coding platform, to facilitate documentation of areas in which respondents described both similar and varied perceptions. The team members then summarized these findings, organized around the research questions, with quotes from interviewees to illustrate key findings.

Findings

As a district, Rowland Schools was committed to offering the PTDP Science Cohort to its teachers. The Director of Instructional Services explained that he was interested in “provid[ing] assessments that are meaningful to teachers [and] inform instruction and feedback toward mastery.” Attentive to the district’s earlier struggles implementing the California Common Core State Standards in Mathematics, he wanted to ensure that teachers had access to “high-quality performance tasks” aligned to the NGSS. He believed that teachers would benefit from the “freedom to immerse themselves in the [NGSS] framework” and would reimagine how they design learning experiences in the classroom and assess student performance. When he heard about LACOE’s PTDP Science Cohort, he stated it was “exactly what [Rowland Schools] needed.”

For Year 1 of the PTDP Science Cohort, he invited TOSAs and a handful of teachers from Rowland Schools to participate in the professional learning series. As a member of the district’s NGSS rollout committee, Ms. S was able to attend. When the training was open to all science teachers the following year, Ms. S returned with three of her four colleagues from Alvarado Intermediate. When reflecting on their participation in the PTDP Science Cohort, they shared how the program increased their understanding of the NGSS, impacted their instructional practices, and improved their development of standards-aligned assessments.

Helping with the Shift to the Next Generation Science Standards

For the Alvarado Intermediate teachers, the shift to the NGSS was a new and demanding period in their professional careers. All of them, except for Mr. N, who had just begun his first year of teaching, recalled the concern that teachers experienced. Ms. D, a teacher for more than 30 years, remembered, “When we changed to NGSS, [it was] very challenging.” Teachers described the necessity to learn new concepts, such as Performance Expectations and the three NGSS foundational dimensions: Science and Engineering Practices, Disciplinary Core Ideas, and Crosscutting Concepts. The science-content TOSA for the district affirmed, “Everything changed [after implementing the NGSS]. [We had to] learn how to incorporate Disciplinary Core Ideas [and] Crosscutting Concepts.”

According to the teachers at Alvarado Intermediate, the PTDP Science Cohort helped them gain a deeper understanding of the NGSS. They appreciated the opportunity to “dig in” and “struggle” with the various components of the NGSS as they engaged in performance task development activities during their professional learning. As many of the teachers noted, they needed time to comprehend the three foundational dimensions and the other concepts in order to “translate” the NGSS for their students.

Beyond the workshops, the Alvarado Intermediate teachers continued to deepen their NGSS knowledge. Ms. A, a teacher at the school for six years, observed that after they all went to the workshops, they would “come back and have meaningful conversations” about what they learned related to the NGSS, performance expectations, and supporting students. As a group, they worked collaboratively to implement the NGSS not only at their school, but also in their district. Aware of limited preparation for NGSS rollout for other grade levels, they developed an NGSS performance task for sixth grade on weather conditions while also revising an eighth-grade task on geological time for their students.

Evolving Views on Performance Task Development

When they began the PTDP Science Cohort training, the three experienced Alvarado Intermediate teachers reported that they felt some apprehension about designing performance tasks. All of them expressed concern that they were “teaching to the test.” Ms. D contended, “That’s cheating. You’re setting [students] up.” However, she and the other teachers asserted that soon after taking part in the Science Cohort trainings, they recognized that “tests need to mirror” what they teach. As Ms. A recounted, “They used to say, ‘Don’t teach to the test.’ But how can you test what you don’t teach?” Ms. S agreed: “We’re the ones that are creating the [performance task], so we are supporting our students.” They understood that rather than simply supplying answers to students, performance tasks pose real-world scenarios and problems and require students to critically analyze and synthesize information to demonstrate their knowledge.

All of the teachers reflected on how students effectively engaged with the science through performance tasks. Ms. S observed that “students [are] so used to rote memorization ... that the critical thinking component has been a huge piece.” Outlining the steps that students experience throughout a performance task, she commented, “Stimulus, options, visuals. Long questions. ... They go through this process. ... You have to build that into the class. And they’re going to get that on the test [CAST].”

Ms. S. recalled the reaction of one of her students after he completed a performance task assessment that she had constructed: “One of my best students took it and he said, ‘I’m done!’ I could understand [his relief]. He did well but he used his brain in a different way.” Her colleague, Ms. A, concurred: “[Before] they were stressed to get the right answer rather than [ask] does the answer make sense. Now they have to defend their answer, not get the right answer.” Ms. T commented that she was “heartened” when she witnessed her students proving that they “actually know the material at or above level” as a result of her shift to incorporate performance task development in her teaching. Based on his students’ enthusiasm and engagement, Mr. N deemed the work of creating, presenting, and assessing performance tasks as “tedious,” but worthwhile.

Shifting Instructional Practices to Integrate NGSS-Aligned Performance Tasks

To facilitate the successful adoption of NGSS-aligned performance tasks in their classes, the teachers at Alvarado Intermediate made significant changes to their instructional practices. Informed by their

participation in the PTDP Science Cohort, they embedded strategies in their teaching, such as question types, scaffolding, and expected vocabulary. They also incorporated NGSS concepts, such as Claim Evidence Reasoning and Science Engineering Practices. Ms. S explained that performance task development helped the teachers structure daily instruction and support students. She elaborated that by adapting their instructional practices, students “see the process, see how we’re building” their knowledge and expertise in the NGSS and CAST to “set them up for success.”

When visiting Ms. S’s class, the WestEd researchers observed firsthand the teacher’s efforts to support students’ understanding of NGSS concepts through a performance task. During the first visit in January, Ms. S was preparing her students for a class activity on the geological time scale. While showing a video about analyzing rock formations to establish the relative age of major events in Earth’s history, Ms. S did not ask her students what they knew about specific epochs or periods. Rather she had her students record what they observed about rock strata and create a claim statement based on their observations. She also encouraged students to use scientific language and academic vocabulary to articulate their scientific knowledge with one another. When the students engaged in the performance task class activity a month later during a follow-up classroom observation, they demonstrated their depth of understanding and applied their learning in context, which allowed them to articulate their thinking process and construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth’s 4.6-billion-year history.

Looking Forward

When considering the future of the PTDP, the LACOE administrator and consultant discussed different options. In their interview, the LACOE consultant noted, “Pedagogy is critical. Performance assessment pedagogy needs to shift to an inquiry model. ... That’s the next thing.” The LACOE consultant elaborated, “Teachers struggle with using questioning as a tool to help students think through difficult items within a task.” According to the consultant, when educators provide students with the answer to difficult parts of the tasks and demonstrate how it should be done, they miss an opportunity to support students in developing their own critical reasoning skills. She asserted that this focus on pedagogy is necessary “to realize the full potential of performance tasks.”

The LACOE consultant acknowledged that the performance tasks that teachers produced in the PDTP are “perfectly imperfect performance tasks.” She explained that “It’s not really about the perfect performance task. It’s more about educators deepening their understanding of the standards and reflecting on their own practice.” She asserted that these are critical experiences for educators in the process of creating performance tasks.

Another area of interest they raised was continuous improvement. The LACOE administrator posed the question, “What do you do with those data after scoring is complete?” Reflecting on her own question, she observed that schools and districts should use that data to inform a continuous improvement cycle. According to the administrator, educators need support to further their understanding of the development of performance tasks as a formative assessment process and build their capacity to engage in continuous improvement to improve and better support teaching and learning. With this case study,

WestEd hopes to support LACOE's commitment to its ongoing work with the PTDP and future connections to continuous improvement practices.

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Appendix A. Sample Performance Task from the PTDP Science Cohort

This appendix features an unedited reproduction of a grade 8 performance task co-developed by the teacher participants during the Year 2 PTDP Science Cohort.

One Giant Leap Grade 8 Performance Task

Co-Developed by:
Beach Cities Performance Task Development Project 8th
Grade Team, WestEd, and the Los Angeles County Office
of Education

One Giant Leap
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Los Angeles County Performance Task Development Project

Introduction

In the spring of 2015, instructional leaders from across Los Angeles County participated in a two-day Building Educator Assessment Literacy (BEAL) training as a means to strengthen their understanding of the connection between the California state standards and the annual assessment of student performance and progress in English Language Arts/Literacy and Mathematics. Beyond a “scoring calibration” session, the BEAL project provided participants tools to connect performance assessment to instructional practice.

In 2016, teacher leaders from the Antelope Valley Curriculum Advisory Council requested additional training to build their understanding of what constitutes a valid and reliable performance assessment. Funded by Los Angeles County Office of Education (LACOE) through the Quality Education Investment Act, Stanford Center for Assessment and Learning Equity (SCALE) was contracted to work directly with an identified team of classroom teachers and instructional leaders from participating Antelope Valley districts. The goal of this project was to build teacher capacity through the development, administration and scoring of grade level mathematics performance tasks.

Due to the enormous success and interest in the Antelope Valley Common Assessment Project, two NGSS cohorts from Los Angeles County were added to the project in 2017. The project evolved into the Los Angeles County Performance Task Development Project (PTDP) with the intention of creating performance assessments in both Mathematics and Science (aligned to the Next Generation Science Standards, NGSS).

WestEd science assessment experts joined the project in 2018, directing a second round of NGSS performance task writing. The performance assessments created in year two purposely set out to include CAST item types in an effort to align these tasks with the California Science Test (CAST). Although slightly different from the first generation of performance tasks, year two tasks bring diversity to the task bank and provide users with a range of performance assessment experiences.

LACOE thanks the following districts for their dedication to the NGSS Performance Task Development Project. We wish to recognize the teachers and instructional coaches who lent their time, instructional expertise, and insight to the authoring of these performance assessments.

Table: NGSS Performance Task Development Participants

Beach Cities (NGSS)	San Gabriel Valley (NGSS)
El Segundo USD	Bonita USD
Hawthorne SD	Charter Oak USD
Hermosa Beach City SD	El Monte City School District
Manhattan Beach USD	El Monte UHSD
Palos Verdes Peninsula USD	Hacienda La Puente USD
Redondo Beach USD	Lancaster SD
Torrance USD	Monrovia USD
Wiseburn SD	Rowland USD

LACOE wishes to recognize the contributions of Theresa Morris of Envision Learning Partners, Lauren Stoll and Susan Schultz of SCALE, and Cinda Parton, Meghan Bell, and Erika Gasper of WestEd, for providing their guidance during the development, administration, scoring and vetting of these performance assessments.

The performance tasks co-developed by the instructional leaders from the participating Los Angeles County Cohorts, SCALE, and WestEd are available under a *Creative Commons Attribution*.

NGSS Alignment

Performance Expectation

MS-PS2-4. Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.

Clarification Statement: Examples of evidence for arguments could include data generated from simulations or digital tools; and charts displaying mass, strength of interaction, distance from the Sun, and orbital periods of objects within the solar system.] [Assessment Boundary: Assessment does not include Newton's Law of Gravitation or Kepler's Laws.]

Table: NGSS Alignment

SEP	DCI	CCC
<p><i>Engage in an argument from evidence:</i> Construct and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem</p>	<p><i>PS2.B Types of Interactions:</i> Gravitational forces are always attractive. There is a gravitational force between any two masses, but it is very small except when one or both of the objects have large mass - e.g., Earth and the sun.</p>	<p><i>Systems and System Models:</i> Models can be used to represent systems and their interactions -such as inputs, processes and outputs - and energy and matter flows within systems.</p>

Classroom Activity

Grade 8: One Giant Leap

Key Concepts and Vocabulary

Gravity
Mass

Resources Needed

Projector/Computer Set-Up or Individual Student Viewing Devices
[Astronaut Jumps on Moon video](#)

Classroom Activity

Teacher: On July 20, 1969, astronauts Buzz Aldrin and Neil Armstrong were the first humans to land on the surface of the Moon. Neil Armstrong famously said, "*That's **one small step** for man, **one giant leap** for mankind.*" Although moving around in a bulky spacesuit is quite difficult no matter the location, they noticed they were able to jump higher on the surface of the Moon compared to the surface of Earth.

Teacher instructs students to stand up and jump here on Earth.

Teacher has students turn to a partner and predict how jumping on the moon might be different.

Teacher shows [Astronaut Jumps on Moon video](#) and instructs students to compare their thoughts to what they observe.

Avoid discussing how mass is related to gravity and that gravity is an attractive force.

Sources: Include links to any useful videos or websites.

[Astronaut Jumps on Moon video](#)

Performance Task

Grade 8: One Giant Leap

The gravitational forces on the Moon are different from the gravitational forces on Earth. After noticing the difference, the astronauts decided to conduct some tests.

On Earth, the astronaut can vertically jump 0.45 meters and land back on Earth's surface in 1 second. On the moon, the same jump by the astronaut has a height of 3 meters and takes a total of 4 seconds.

Question 1

What can explain why the astronaut lands back on the surface after jumping in both locations?

- A. Because gravity is attractive in both locations
- B. Because gravity is repulsive in both locations
- C. Because gravity is attractive on Earth but repulsive on the Moon
- D. Because gravity is attractive on the Moon but repulsive on Earth

Question 2

Below are two diagrams of an astronaut on the Moon versus an astronaut on Earth. Draw an arrow on each diagram to represent the force and direction of gravity acting on the astronaut at these locations. Use arrow length to show the force of gravity and point the arrow in the direction of the gravitational force.

Diagram 1: Astronaut on the Moon

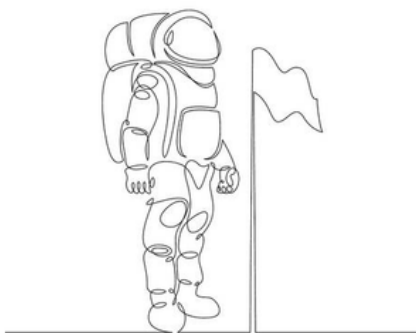
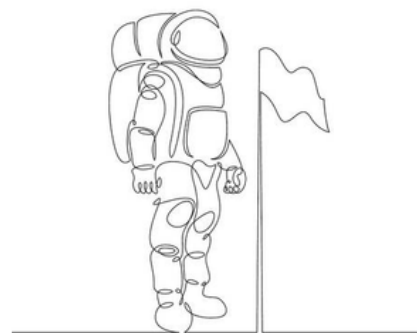


Diagram 2: Astronaut on Earth



Curious as to what caused the difference in their test results, the astronauts decide to do some research on the Earth versus the Moon. The data table below shows their findings:

Table 1: Features of Earth and Moon

Feature	Earth	Moon
<i>Rotational Period</i> <i>(time to spin on its axis)</i>	24 hours	27.3 days
<i>Time to Orbit the Sun</i>	365.25 days	365.25 days
<i>Mass</i> <i>(compared to Earth)</i>	1 Earth Mass	0.012 Earth Masses
<i>Average Distance from Sun</i>	150,000,000 km	~150,000,000 km

Question 3

Based on the data in Table 1, what is the most likely contributor to the difference in gravity on Earth and the Moon?

- A. Rotational period (time to spin on its axis)
- B. Time to orbit the Sun
- C. Mass (compared to Earth)
- D. Average distance from the Sun

Future space missions have been focusing on human exploration and colonization of Mars. The astronauts wonder how jump data from Mars would compare to the data from Earth and the moon.

Table 2: Comparison of Features of Earth, Moon and Mars

Feature	Earth	Moon	Mars
<i>Rotational Period (time to spin on its axis)</i>	24 hours	27.3 days	24 hours 39 minutes
<i>Time to Orbit the Sun</i>	365.25 days	365.25 days	687 days
<i>Mass (compared to Earth)</i>	1 Earth mass	0.012 Earth masses	0.11 Earth masses
<i>Average Distance from Sun</i>	150,000,000 km	~150,000,000 km	227,900,000 km

Table 3: Jump Heights and Times of Earth, Moon and Mars

Feature	Earth	Moon	Mars
<i>Jump Height</i>	0.45 m	3 m	?
<i>Jump Time (duration)</i>	1 s	4 s	?

Question 4

An astronaut jumps on the surface of Mars. How would the jump height and jump time be different if that same jump had been made on Earth or the Moon?

- A. The jump height and time will be more on Mars than both the Earth and the Moon.
- B. The jump height and time will be less on Mars than both the Earth and the Moon.
- C. The jump height and time will be more on Mars than the Earth but less on Mars than the Moon.
- D. The jump height and time will be less on Mars than the Earth but more on Mars than the Moon.

Question 5

Use evidence from Table 2 and Table 3 to explain the reasoning for the claim you selected in Question 4.

Scoring Guide

Grade 8: One Giant Leap

Table: Grade 8 Scoring Guide

Question Number	Item Type	Key
1	Multiple choice	1-point response: A
2	Image interaction	2-point response: 1 point - Both gravitational force arrows should be correctly oriented towards the surface of the planet 1 point - The gravitational force arrow for the Moon should be smaller than that of Earth
3	Multiple choice	1-point response: C
4	Multiple choice	1-point response: C
5	Constructed response	<p>3-point full credit response:</p> <p><u>The response should use the following evidence: (2 points)</u></p> <ul style="list-style-type: none"> • The mass of Earth is 1 Earth mass, the mass of the moon is 0.012 Earth masses, and the mass of Mars is 0.11 Earth masses. AND • The astronauts jumped 0.45m on Earth and 3m on the moon. OR • The astronauts took 1 second to land on Earth and 4 seconds to land on the moon. <p><u>AND the following reasoning: (1 point)</u></p> <ul style="list-style-type: none"> • Scientific principle-gravitational force increases with the mass of the objects. <p><u>Exemplars</u> <i>One example of full-credit, “typical” response:</i></p> <p>Table 2 shows us that the mass of the moon is 0.012 Earth masses and the mass of Mars is 0.11 Earth masses. This means that Mars with a mass of 0.11 Earth masses is more massive than the moon but less massive than Earth. Since gravitational force increases with mass, Mars should have more gravity than the moon but not as much gravity as Earth. Table 3 shows us</p>

Question Number	Item Type	Key
		<p>that on Earth, the astronaut can jump 0.45m. On the moon (where there is less gravity because it has less mass) the same astronaut can jump higher - 3m. This means that an astronaut jumping on Mars should be able to jump higher than they can on Earth but not as high as they can on the moon.</p> <p><i>Another example of a full-credit, "typical" response:</i></p> <p>Looking at the data in Table 2, we can see that the mass of Mars is 0.11 Earth masses. When we compare this to the mass of Earth (1 Earth mass) and the mass of the moon (0.012 Earth masses) we see that Mars is more massive than the moon but less massive than Earth. Objects with more mass have more gravity so Mars should have more gravity than the moon but not as much gravity as Earth. In Table 3 we see that on Earth the astronaut's jump takes 1 second. On the moon the same jump takes 4 seconds. So, the stronger the force of gravity the less time the jump takes. From this we can conclude that on Mars the jump time will be more than the Earth but less than the moon because the gravity on Mars is less than the Earth but more than the moon.</p> <p>2-point response:</p> <p><u>The response should use the following evidence: (1 point)</u></p> <ul style="list-style-type: none"> • The mass of Earth is 1 Earth mass, the mass of the moon is 0.012 Earth masses, and the mass of Mars is 0.11 Earth masses. <p><u>AND the following reasoning: (1 point)</u></p> <ul style="list-style-type: none"> • Scientific principle-gravitational force increases with the mass of the objects <p><u>Exemplars</u></p> <p><i>Example of a "typical" two-point response:</i></p> <ul style="list-style-type: none"> • The data in Table 2 shows us that the mass of the moon is 0.012 Earth masses and the mass of Mars is 0.11 Earth masses. Since the Earth is 1 Earth mass, Mars would have less mass than the Earth but more mass than the moon. Since objects with more mass have more gravity, Mars

Question Number	Item Type	Key
		<p>would be expected to have less gravity than the Earth but more gravity than the moon.</p> <p>1-point response:</p> <p><u>The response should use the following evidence:</u></p> <ul style="list-style-type: none"> • The mass of Earth is 1 Earth mass, the mass of the moon is 0.012 Earth masses, and the mass of Mars is 0.11 Earth masses. <p><u>OR the following reasoning:</u></p> <ul style="list-style-type: none"> • Scientific principle-gravitational force increases with the mass of the objects <p><u>Exemplars</u></p> <p><i>Examples of “typical” one-point responses:</i></p> <ul style="list-style-type: none"> • In Table 2 it shows that the mass of Mars is 0.11 Earth masses so Mars is more massive than the moon (0.012 Earth masses) and less massive than the Earth (1 Earth mass). (missing scientific principles) • On Mars the astronaut will jump higher than on Earth but less than on the moon because gravity increases with mass. (lacking use of evidence from data tables)

Anchor Set

Grade 8: One Giant Leap

Question 5 (3 points maximum)

Sample:

Table two states the following: the moon is 0.012 earth masses, and Mars is 0.11 earth masses. This is why the jump on Mars would be higher and longer than the jump on earth, but shorter in both height & time when compared to a jump on the moon. The force of gravity that attracts objects to one another is determined by mass, where more massive objects have a stronger gravitational pull, and less massive objects have a weaker pull. This can be seen in table 3. Table 3 states that a jump on earth was 0.45m and one second long. On the moon, a jump is 3m, and takes 1.6 seconds. This difference ~~in~~ ~~caused by~~ in jump height and duration is caused by the difference in mass between earth and the moon, and therefore the difference in gravitational pull.

Score: 3

Description and Rationale:

Student provides data for mass of Earth, Mars and Moon and data for the height and time of jump. The student states the relationship between mass and gravity.

Sample:

The earth masses on the moon is 0.012. This is less than Mars, 0.11. If earth is 1, the jump $\frac{3}{4}$ time on the moon is more. In this case, 3m height in 4 seconds on the moon. Earth is 0.45m height in 1 second due to the larger mass. Mars is in between these two because the mass is more than the mass of the moon, but less than the mass of the earth.

Score: 2

Description and Rationale:

Student gives data for mass of Earth, Mars and Moon and data for jump height and time but does not state the relationship between mass and gravity.

Sample:

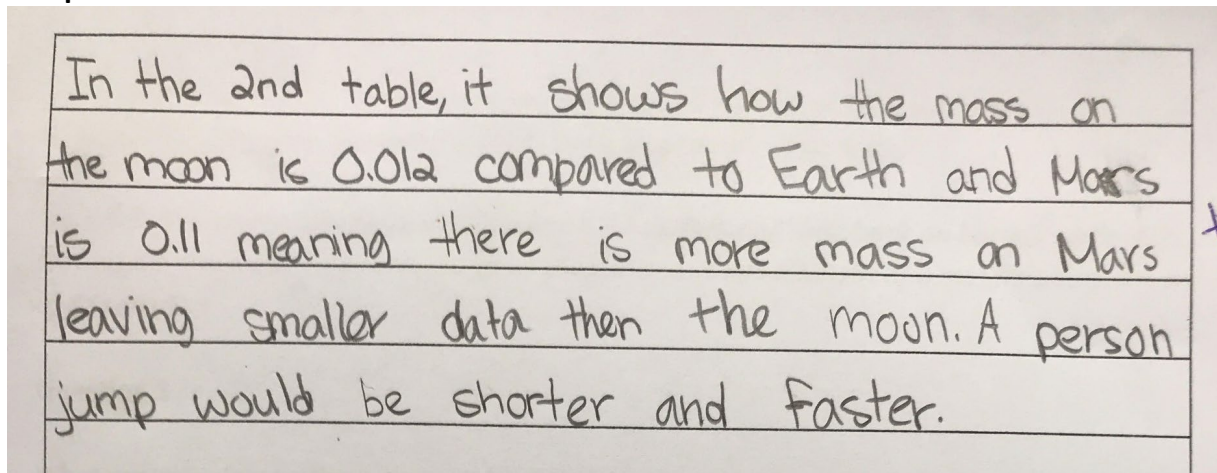
On table 2, it states that the mass of Mars is 0.11 Earth masses, whereas the moon is only 0.012 Earth masses. This shows how Mars weighs less than Earth, but more than the moon. On question 3, I identified that the moon has less of a gravitational pull than Earth because it has less mass than Earth. This led to my conclusion the mass has a direct relationship with gravitational pull, which affects your jump height. Therefore, if Mars has less mass than the Earth, but more mass than the moon, Mars' gravitational pull will be greater than the pull of the moon, and less than Earth. This means you can jump higher on Mars than you can on Earth, but your jump time and height is less on Mars than on the moon.

Score: 2

Description and Rationale:

Student includes data on the mass of Earth, Mars and Moon but does not include data on jump height and time. Student does state the relationship between mass and gravity.

Sample:



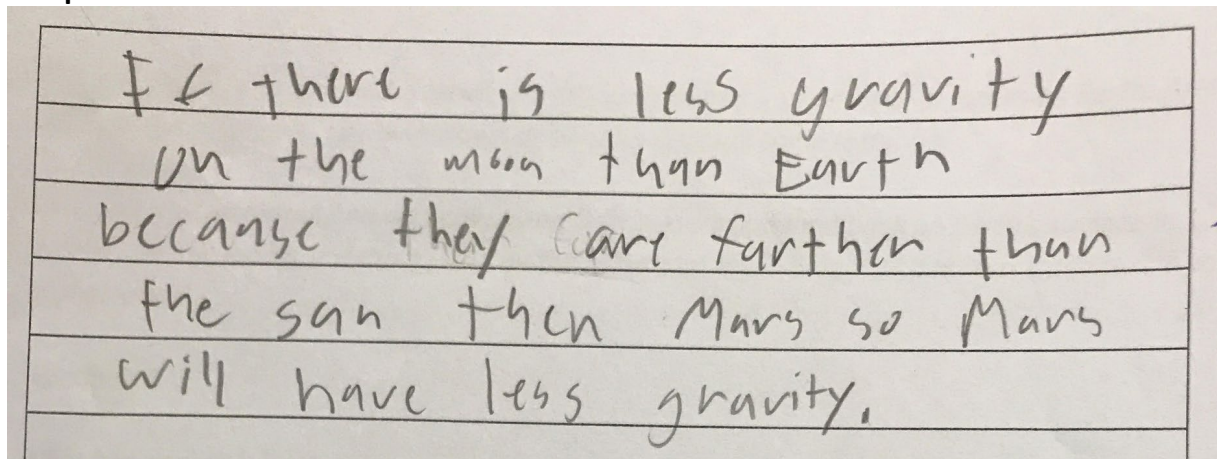
In the 2nd table, it shows how the mass on the moon is 0.012 compared to Earth and Mars is 0.11 meaning there is more mass on Mars leaving smaller data then the moon. A person jump would be shorter and faster.

Score: 1

Description and Rationale:

Student uses data for mass of Earth, Mars and Moon. Does not include data for jump height and time or the relationship between gravity and mass.

Sample:



If there is less gravity on the moon than Earth because they are farther than the sun then Mars so Mars will have less gravity.

Score: 0

Description and Rationale:

Student does not include data for mass or jump height and time. There is no reference to the relationship between mass and gravity.

Sample:

According to table 2, the moon takes 27.3 days to spin on its axis once. Also, the Earth and Mars have nearly the same amount of time to spin on its axis. So, I predicted, the longer it takes to spin on its axis, the longer it is to jump up and back from wherever you are going to jump. Also on Table 2, the time it takes for Mars to spin around the sun is 687 days while Earth takes 365 days so maybe the longer it takes ^{to spin} around the sun, the less gravity there are. Therefore, the time it takes to jump and back on Mars is longer than Earth, but less on the moon.

Score: 0

Description and Rationale:

Student incorrectly tries to use data for rotation and revolution to explain differences in gravity and jump time. Student does not use mass data or show the relationship between mass and gravity.

Appendix B. Interview Protocol

Figure B1. Interview Protocol Template

Question	Comments	Notes
1. How did you become involved in the Science Cohort PTDP? How long have you participated in the program?	Sample Comments	Sample Notes
2. Tell us about your experience in the program? <ul style="list-style-type: none"> • What was most beneficial? • What was least beneficial? 	Sample Comments	Sample Notes
3. How has the PTDP influenced your teaching or teaching at the site(s) you support?	Sample Comments	Sample Notes
4. How has the PTDP influenced your relationship with your colleagues?	Sample Comments	Sample Notes
5. How has the PTDP been different from other PD opportunities?	Sample Comments	Sample Notes