Student Engagement in Assessments: What Students and Teachers Find Engaging

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Introduction

Although research has shown that student engagement is strongly related to performance on assessment tasks, especially for traditionally underserved subgroups of students, including students of color, students living in poverty, students with special needs, and students for whom English is a second language (Arbuthnot, 2011; Darling-Hammond et al., 2008; Walkington, 2013), increasing student engagement has not been the goal of standardized tests of content knowledge. In the traditional assessment paradigm, attention to engagement has been displaced by a definition of equity that focuses on issues of bias and accessibility. A common tactic used to avoid bias has been to create highly decontextualized test items. This tactic has had the inadvertent result of decreasing students' opportunities to create meaning in tasks as well as their motivation to cognitively invest in them, thereby undermining students' opportunities to adequately demonstrate their knowledge and skills.

Recent state and federal policies, however, are changing the assessment landscape. For example, the adoption of the Common Core State Standards has spurred a renewed interest in the development of more balanced assessments that are designed to measure higher order thinking skills and support deeper learning. More balanced assessments include performance-based tasks that tap into students' higher order thinking skills and require students to perform, create, and demonstrate their knowledge, skills, and abilities. In addition, the reauthorization of the Elementary and Secondary Education Act of 1965 (known as the Every Student Succeeds Act [ESSA]), which was signed by President Obama in 2015, includes assessment provisions that may offer opportunities to increase student engagement in large-scale assessments. The act specifies that state and local assessments should "involve multiple up-to-date measures of student academic achievement, including measures that assess higher-order thinking skills and understanding, which may include measures of student academic growth and may be partially delivered in the form of portfolios, projects, or extended performance tasks" (ESSA, 2015, § 1117).

Assessments that tap into students' higher order thinking skills, such as performance-based tasks, can support the development of students' deeper understanding of content (Vogler, 2002) and increase student engagement in learning (Foote, 2005). Thus, the changing state and federal landscape offers a ripe opportunity to develop performance-based assessments that allow students to demonstrate their evaluation, synthesis, analysis, and application skills—without sacrificing their engagement.

The goal of this study is to provide guidance to educators, assessment developers, and policymakers on how to increase student engagement in performance-based assessments. We take up this challenge by examining how students and teachers conceptualize and recognize engagement features in performance-based tasks. To provide theoretical grounding for this study, we begin by defining student engagement as a combination of the following concepts: relevance, authenticity, autonomy, collaboration, higher order thinking skills, and self-assessment. Next, based on interviews of study participants, we report on what qualities students and teachers perceive to be engaging in assessments.

We find that this study confirms the importance of these six engagement concepts, adding an understanding of the nuance and features of each. We conclude by discussing how student engagement may be meaningfully incorporated into assessment tasks so that all students are more fully engaged and motivated to demonstrate their understanding.

Literature Review

We reviewed the literature and identified six concepts that grounded our understanding of student engagement.

Relevance

The concept of *relevance* refers to the process by which a student perceives that a task will satisfy important personal needs, motives, or values (Keller, 1983). Relevance fuels a student's motivation to learn (Brophy, 1986). More specifically, relevance answers the question "Why does the educational content matter to the student?" and provides the student with an intrinsic reason for doing a task. Relevance may be fostered by making a connection to students' lived experiences, interests, or prior knowledge. These connections create a "need to know" for students and offer a reason for doing the task.

When task scenarios are used to connect a task to students' own lives, engagement and performance improve (Meier, 2008). For example, Walkington (2013) found that context personalization increased student performance on algebraic word problems. She studied 145 ninth graders in three algebra classes where teachers utilized Cognitive Tutor Algebra, a computer-based tutoring system that individualizes instruction through adaptive problem selection, hints, and feedback. Students in the experimental group solved algebraic word problems matched to their self-reported interests (e.g., sports, music, art, games). The research showed that connecting the math problems to students' interests increased student performance, especially with more cognitively challenging problems and for struggling students. In addition, problems relevant to students' lives (e.g., paying a cell phone bill) were easier for students to solve than those not connected to their experience, even when the problems were contextualized to an expressed interest (Walkington & Sherman, 2012).

Attending to the relevance of assessment items is critical for traditionally underserved students. Students of privileged backgrounds have been found to be more able to compartmentalize and carry out decontextualized tasks without immediate relevance for them (Darling-Hammond, et al., 2008) than are traditionally underserved students. Historically privileged students also tend to be more "test wise" or savvy—that is, more likely to possess the unspoken skills and strategies needed to successfully tackle traditional tests (Arbuthnot, 2011). These findings reiterate the importance of making assessment tasks more relevant by making connections to students' lived experiences, interests, or prior knowledge.

Authenticity

The concept of *authenticity* refers to the extent to which a task requires students to solve real-world problems and has value beyond school (Lombardi, 2007). Real-world problems reflect tasks that are encountered in work and everyday settings, are often complex, and require sustained effort to solve. The criterion of value beyond school means that the creation of products and performances has personal, utilitarian, or social significance aside from assessing the student's knowledge and skills (Newmann, Marks, & Gamoran, 1996). That is, the products that students create (e.g., a science lab or research report) have an audience or purpose beyond "getting the grade." Research by Newmann and his colleagues found that when students in elementary and middle school classrooms engage in authentic work, the quality of their academic performance increases (Newmann & Associates, 1996; Newmann, Bryk, & Nagaoka, 2001).

Authenticity may be fostered by creating tasks that promote realistic problem-solving processes (Smith, 1987) and bear significant resemblance to activities conducted by real practitioners (Brown, Collins, & Duguid, 1989). Exposure to such activities rather than to disjointed abstract concepts and skills allows students to "tease out the way a mathematician or historian looks at the world and solves emergent problems" (Brown, Collins, & Duguid, 1989, p. 34). Through authentic tasks and activities, students learn science not by simply memorizing facts or following scientific procedures: rather, they engage in scientific discourse or activities in ways that a scientist would.

Other strategies for fostering authenticity in learning tasks include the use of problem-based learning instructional approaches and the use of contextualized problems in math. *Problem-based learning* is defined as an "instructional method characterized by the use of 'real-world' problems as a context for students to learn critical thinking and problem-solving skills" (Duch, 1995). Finkelstein, Hanson, C.-W. Huang, Hirschman, and M. Huang (2010) conducted a randomized controlled trial study to assess the impacts on student learning of a problem-based learning approach to teaching high school economics. The intervention teachers received professional development to implement the Problem Based Economics curriculum developed by the Buck Institute. The control teachers implemented a textbook-driven economics curriculum, attended their regular annual professional development activities during the school year, and continued their usual instructional practices. The researchers found that students whose teachers taught economics through the problem-based learning approach significantly outperformed their control group peers on the National Council on Economic Education's Test of Economic Literacy. Students in the intervention group also performed better than the control group in applying problem-solving skills to real-world economic problems.

Autonomy

Student engagement may also be improved through contexts that support autonomy (Connell & Wellborn, 1990). The concept of *autonomy* derives from self-determination theory and refers to the extent to which a student is able to choose or self-initiate an action, or experience an action, for which the student is responsible (Deci & Ryan, 1987). Autonomy may be supported by providing students with latitude and decision-making opportunities (Skinner & Belmont, 1993), and, in particular, affording students opportunities to make cognitive choices as well as organizational and procedural choices regarding their work (Stefanou, Perencevich, DiCintio, & Turner, 2004).

Research has shown that students' motivation and learning is enhanced by offering them choice (Iyengar & Lepper, 1999). For example, Zuckerman, Porac, Lathin, Smith, and Deci (1978) studied 40 pairs of undergraduate students from the University of Rochester. Within the pairs, one student was assigned the responsibility of choosing the activities to work on and how long to spend working on them, while the second student was assigned to perform the activities and durations chosen by the first. The researchers found that the students in the choice condition showed significantly greater intrinsic motivation for the task activity than the students in the no-choice condition. In a separate study, Harter (1978) examined whether students actively seek out challenging tasks if given a choice. She gave 40 sixth grade students anagrams to solve containing three to six letters. When students were given autonomy to choose their own levels of difficulty, they demonstrated a preference for more difficult work. Chase, Chin, Oppezzo, and Schwartz (2009) also examined the effects of choice on student learning. Students working with an intelligent software environment called Teachable Agents were placed in two conditions. Students in the teaching condition were told that by creating concept maps they were teaching the computer character—a "teachable agent"—to answer questions. Students in the self condition were told that they were making a concept map simply to help themselves learn. On posttests of learning, students in the teaching condition outperformed the students in the self condition, choosing to spend more time working on their maps, reading more relevant resources, and editing their maps. The researchers concluded that students' ability to choose what and how to learn had a positive impact on their learning.

Collaboration

Collaboration has been found to greatly increase student engagement (D. Johnson & R. Johnson, 1987; Slavin, 1990). The concept of *student collaboration* refers to students working with each other in pairs or small groups to ask questions and to share and build on each other's ideas. This concept builds upon cognitive theories, namely Piaget's concept of social arbitrary knowledge, in which interactions with others are key to learning, and Vygotsky's concept of the zone of proximal development, in which learners' problem solving skills are furthered under adult guidance or in collaboration with more capable peers (Slavin, 1980). In addition, student talk (i.e., students explaining and justifying their interpretations of activities and solution attempts) has been found to improve student learning (Yackel, Cobb, & Wood, 1991), and collaboration provides opportunities for students to engage in such talk. Collaboration can also increase student motivation when a group reward system relies on individuals attaining their goals through the group's success, facilitating students' encouragement of each other's effort and learning (Slavin, 1990). In addition, collaboration has been found to foster norms that promote equity, with attention to status issues in student groups (Boaler, 2008).

Student collaboration has been found to increase student performance in testing settings. For example, Skidmore and Aagaard (2004) studied the performance of 141 undergraduate students seeking entry to a teacher education program at a Mid-South state university. The students were in one of four sections of the same course taught by the same instructor. Skidmore and Aagaard analyzed performance differences for five multiple-choice exams. Students worked independently on the first and second exams. For the third exam, they were permitted to bring an 8½-by-11-inch "cheat sheet" of notes to the exam. For the fourth exam, they were encouraged to discuss the exam questions in groups to which they had been randomly assigned, but stratified based on the average performance on the first two exams to ensure that each group included at least one student who performed at the A or B level, one who had performed at the C level, and one who had performed at the D or F level, to create heterogeneous grade groups. Students discussed the exam questions in the hallway but did not take notes or write on their exam papers during the discussions. They then returned to the classroom to take the exam independently. For the fifth exam, students were again allowed to bring a "cheat sheet" and also engaged in discussions after they had been assigned into homogeneous grade groups (i.e., students who earned an A average were group together and students who earned a B average were grouped together, and so on), in the same fashion as with the heterogeneous grade groups.

The heterogeneous and homogeneous grade group treatments led to the greatest score gains over scores earned under the traditional testing condition, with the heterogeneously designed discussion groups resulting in the largest positive effect. Skidmore and Aagaard (2004) suggest that collaboration serves as a scaffold for managing the mechanics of testing, such as considering all responses prior to selecting a response. Further, collaboration may improve test performance by fostering motivation and offering opportunities for social interaction and student talk.

Higher Order Thinking Skills

The concept of *higher order thinking skills* refers to the processes of analyzing, interpreting, and/or manipulating information; such skills go beyond routine mental work such as simple recall or retrieval of prior knowledge. Tasks that focus on higher order thinking skills may, for example, require students to craft a persuasive essay about a current social issue (e.g., nuclear power usage, teen curfews, driving restrictions) by evaluating competing viewpoints and using evidence to support their arguments (Darling-Hammond, Ancess, & Falk, 1995).

Involvement in higher order thinking has been correlated with increased student engagement, as found through analysis of results from the National Survey of Student Engagement (NSSE, 2016) and the Australasian Survey of Student Engagement (AUSSE, 2012). The NSSE, first conducted in 1999, is an annual survey administered to first- and second-year college students at hundreds of four-year universities throughout the United States. The results of the NSSE survey show that academic challenge and the complexity of cognitive tasks are associated with greater student engagement (Kuh, Kinzie, Schuh, & Whitt, 2005). The AUSSE indicates similar findings. Building from the work of the NSSE, the AUSSE was first administered to a representative sample of 25 Australian and New Zealand university students in 2007. Results from the AUSSE indicate that students' involvement in higher order forms of learning were correlated with improved student engagement. *Higher order forms of learning* involve "analysis, synthesis, evaluation, and application" as defined by Coates (2008, p. 21).

Studies of children's efforts in puzzle solving also indicate increased engagement when the task has multiple representations and access points. Tasks with multiple representations or sources elicit students' higher order thinking because the children must interpret and analyze these multiple sources to complete the task (Xie, Antle, & Motamedi, 2008). Emphasizing tasks that involve students' higher order thinking skills, such as performance tasks, may be a "win–win" for assessment purposes because of the importance of students' development of such skills in addition to increased engagement.

Self-Assessment

The concept of *self-assessment* refers to students reflecting on their own thinking, answers, and explanations. Self-assessment is considered to be feedback that students give to themselves and is considered a form of formative assessment (Black & Wiliam, 1998). *Feedback* has been defined as "information about how successfully something has been or is being done" (Sadler, 1989, p. 120). Feedback has been found to improve student achievement when it is specific about the quality of the work, provides advice to improve the work, and avoids comparison with other students. Effective feedback has been argued to include three components: students (1) learn to monitor their own work while producing it, (2) understand what "high quality" work looks like, and (3) are able to compare their own work to the standard of "high quality" (Sadler, 1989). For feedback to the student to be productive, the task itself must be clear (Sadler, 1989) and teachers must clearly communicate task expectations and ways to be successful in the task (Black & Wiliam, 1998).

Student self-assessment can enhance cognitive, emotional, and behavioral engagement, particularly for students from low socioeconomic backgrounds (Munns & Woodward, 2006).

Hattie and Timperley (2007) suggest that feedback must be given to students within a learning context and with suggestions for improvement rather than emphasis on students' lack of understanding (p. 82). Hattie and Timperley refer to Sadler when suggesting that feedback's function is "closing the gap between where students are and where they are aiming to be" (p. 90). They suggest a framework in which students ask themselves, "Where am I going?" "How am I going?" and "Where to next?" (p. 86).

Students may benefit from self-assessment throughout the process of taking an exam. For example, assessments can prompt reflection and remind students to monitor their thinking by means of questions such as "What did you find out about your problem-solving skills and strategies while doing this activity?" Computer-testing technology may have the capability to provide "auto-feedback" to students (e.g., clues to the causes of difficulties as well as opportunities for attacking the task in a new, more informed way). For example, a pop-up response may alert a student that an answer is not in the expected format, similar to online forms and surveys where the form alerts the user "This response should be numerical" or "This response should be in words."

Method

The purpose of this study is to understand students' and teachers' perceptions of what qualities make performance-based assessments engaging. Specifically, we solicited input and suggestions regarding task design, structures, and contexts in order to get a rich sense of what both students and teachers perceived to be most engaging to students.

Participants

The participants in the study were drawn from four urban high schools in the San Francisco Bay Area, called pseudonymously, for the purposes of this study, Oak, Spruce, Pine, and Maple. (See Table 1.)

Student participants. In all four schools, Latino students formed the largest demographic group, ranging from 41 percent to 80 percent of the student body. The African American student population (9–31 percent) formed the second-largest demographic group in three schools; in the fourth school, the second-largest group was the Asian American population (25 percent). Each school had a different demographic group as the third-largest population: African American (15 percent), White (6 percent), Asian American (7 percent), and Pacific Islander (5 percent).

Teacher participants. We recruited eight math teachers from the four high schools: four teachers from Oak, two from Spruce, one from Pine, and one from Maple. Six of the teachers were female; two were male. There was a wide range in the teachers' length of service, with level of experience ranging from the first year of teaching to

Table 1: Student Demographics in Four Bay Area High Schools

School	School type	Latino	African American	Asian American	White	Pacific Islander
Oak HS	Public charter	59%	25%	2%	6%	1%
Spruce HS	Public district	80%	9%	7%	2%	1%
Pine HS	Public district	41%	15%	25%	9%	1%
Maple HS	Independent	64%	31%	0%	0%	5%
State average		52%	6%	11%	26%	1%

Note: Adapted from data from GreatSchools, retrieved on May 26, 2016, from http://www.greatschools.org. GreatSchools cited the data source for Oak, Spruce, and Pine Schools as the California Department of Education based on the 2013-2014 school year. The data source for Maple School was the National Center for Education Statistics based on 2011-2012 school year.

21 years in the classroom. The average teaching experience among the eight teachers was six years. From each teacher's set of classes, the teacher chose one class from which we recruited the student participants. Four teachers were randomly selected to administer one of two performance-based tasks; the remaining four teachers administered the other performance-based task.

Semistructured Interview

From each of the eight classes, we randomly selected three students to participate in a semistructured interview, resulting in 24 student participants. The goal of the interviews was to understand, from the students' perspectives, what made performance-based tasks engaging for them. The interview protocol included questions such as: "What about the performance-based task was engaging to you?" "What about the performance-based task was not engaging?" "If you had to create a performance-based task, what would you do to make it really engaging for students?"

We also asked probing questions about the inclusion of the six engagement concepts if students did not reference them in their answers. This prompting served to ensure that we captured the students' thinking about what made assessments engaging (or not) to the fullest extent possible. The student interviews ranged in length from 15 minutes to half an hour. In addition, all eight teachers participated in one-hour semistructured interviews about their conceptions of what qualities make assessments engaging for students. All interviews were conducted at the high schools during lunch periods or after school. All 32 interviews were audio recorded and transcribed.

Performance-Based Tasks

To ascertain students' conceptions of what makes performance-based tasks engaging, we wanted to ensure that all of the students had a similar task experience from which to draw. For this reason, we administered a performance-based task to each participating teacher's selected math class.

We developed two performance-based tasks for this purpose, "Task A" and "Task B", each of which was conducted during the students' regular math period. (See Appendices A and B.) Both task versions utilized the concept of heart beats and required students to demonstrate related mathematical skills and understandings. Task A focused on farm animals and asked students to model the relationship between the body weight and pulse rate of animals. Task B focused on humans and asked students to estimate the relationship between age and maximum heart rate for themselves and others. In addition, Task B incorporated a specific engagement element; the Task B scenario placed students into the task as an organizer for their community's exercise challenge day, thereby increasing the level of task relevance. The rationale for creating the two task conditions was we hypothesized that students who completed Task B (the version that intentionally incorporated the relevance concept) would experience the task differently than the students who completed Task A, and that they would identify that concept as having increased engagement for them when interviewed. Half of the 24 students we interviewed completed Task A, and the other half completed Task B.

Data Analysis

We used Dedoose (Version 7.1.3, 2016), a software program for qualitative data analysis, to code the interview data via multiple passes. First, we used a deductive approach to analyzing the data. We identified and tagged relevant passages using the six engagement concepts derived from the research literature: relevance, authenticity, autonomy, higher order thinking skills, collaboration, and self-assessment. Second, we recoded the data using an inductive approach to determine and discover how students and teachers conceptualize student engagement. The second level of coding allowed us to reveal nuances between and among the participants in terms of what qualities they think make performance-based tasks engaging. In addition, it allowed us to discern how closely the students' and teachers' conceptions of engagement aligned with the engagement concepts detailed in the research literature. We coded 13 percent of the interviews together to develop interrater reliability and then coded the rest of the data individually. However, we engaged in periodic spot checks of coding to guarantee that the consistency of coding was maintained throughout the analysis process.

Findings

We found that the study both confirms the importance of the six engagement concepts found in the literature and develops their features, adding to an understanding of the nuance and features of each. Table 2 details the major findings. Elaborated descriptions of each finding follow.

Relevance

All 32 of the study participants (24 students and eight teachers), spoke to the importance of making performance-based tasks relevant to students to increase student engagement. Within the data, the participants made 142 references to the need for relevance; this was by far the most discussed strategy for engaging students.

Table 2: Features of Engagement Concepts

Engagement concept	Features identified by students and teachers
Relevance	• Prior experience • Interest • Personalization
Authenticity	• Real-world scenario or data • Utility value • Feasibility • Authentic purpose or audience
Autonomy	• Open-endedness of task • Choice based on students' ability level or desire for challenge • Choice based on students' interests • Choice based on students' desire to socialize
Collaboration	• Help from peers • Sensemaking • Socialization
Higher order thinking skills	• Tasks that are challenging but doable • Multiple representations, solutions, and/or solution strategies
Self-assessment	• Usefulness of self-check reminders • Effect of self-check reminders on performance • Metacognitive engagement • Lack of engagement with self-check reminders

The students and teachers characterized relevance in three ways: prior experience, interest, and personalization. *Prior experience* emphasized relationship to something students have experienced or seen previously, something they are familiar with. *Interest* indicated students' desire to know or learn more about a particular topic or a topic for which students may have a passion. *Personalization* had to do with students' own persons, bodies, private lives, or relationships.

Prior experience. Seven out of 24 students (29 percent) made references to incorporating prior experiences into the performance-based tasks to make them engaging. When asked what advice a student would give to item writers, a student replied, "Base it on something I've done" (PINE.TH.JO.3802–4033). Students also remarked that showing a model of how something is supposed to be done in the task would elicit their engagement. One student commented,

> Like for example with the graph thing, . . . show us how they were supposed to be graphed. So when the kids get this, they will have a feeling of how they do it like, "Okay, we'll have to do this in order to get this." (OAK.LM.AT.4380–4913)

Another student explained how the lack of prior experience impeded her enjoyment of math and acted as barrier for future learning:

> I don't like math. I never liked math. . . . It's just hard for me. Like most people say, "It's easy once you learn how to do it and stuff and learning the tricks." But I've never learned the tricks and it's never been fun. (OAK.LN.KA.4087–4391)

In comparison, six out of eight teachers (75 percent) reported the importance of building on prior experiences in order to engage students in performance-based tasks. For example, one teacher explained, "They have all these background experiences they're bringing into the task. And I think the more of those we can harness, like more often the better, the more engaged students are" (OAK.NO.LA.21078–21692). Another teacher related a similar sentiment about a Smarter Balanced Assessment Consortium exam's performance task:

> It was about roof trusses.. . . . What adolescent is going to know about that? . . . they could do a much better job of trying to find the mathematics that's relevant to the age group they're giving this test to. (PINE.HS.TA.32394–33304)

Teachers also talked about the importance of connecting performance tasks to students' lived experiences. For instance, students could use their experience with older people and family members to understand maximum and minimum heart rates and perhaps conclude, "Oh, obviously, my grandma shouldn't run five laps at top speed around the building because she shouldn't be getting her heart rate up that much" (PINE.HS.TA.16777–17654). Teachers also echoed the students' perceptions that familiarity breeds engagement. A teacher noted,

> They like things that are familiar to them, especially math based. I think that if they get to do math that they know how to do well, they're very engaged . . . so they feel very confident and like, "Oh this looks like something I've done before." (PINE.BA.KY.5887–6910)

Interest. Eighteen out of 24 students (75 percent) talked about the importance of harnessing students' interests in the design of performance-based tasks to elicit student engagement. For example, one student related,

> I thought that [the performance-based task] was engaging because it involves animals and there are some kids who, if you involved something that they like, it will bring them in, and I'm one of those kids. And I love animals, and animals and math go well for me. So that was truly engaging. (OAK.SC.IS.654–921)

When asked how to make performance-based tasks engaging for students, another student advised,

> I would think: "What does the majority of the class like, and what do they all have in common?" when it comes to engaging in things because you can't just do [it] based on a few kids. . . . So find a connection in all the students, what they find engaging, and then you create on this. So that's what I would do. (OAK.SC.IS.5149–5560)

Another student suggested, "So maybe like Jack is at a big sale and he's selling four cookies for a dollar. So if someone wants two cookies, how much would it be? Or stuff like that so that you know how to purchase" (OAK.ON.CH.7193–8007). When pressed why that problem scenario would be engaging for students, he replied, "Because you're working with money and students love money." However, the difficult part about using student interests to design performance-based tasks is that interests are highly individual. What may be interesting to one person may not be interesting to another. A student cautioned, "Yeah [running your own shop or salon] would be interesting to me, but I guess it depends on the student that's actually doing the task" (OAK.LN.KA.6331–6607).

Similarly, six out of eight teachers (75 percent) talked about the need to be mindful of and take into consideration students' interests when designing performance-based tasks. For example, a teacher related,

> I would use a survey in the beginning of the hour. Like I asked specific questions, like "What do you do outside the school?" I asked actually

> one question. I only started doing this for the past couple of years, and it's like: "If you could examine anything with math, what would it be?" (PINE.HS.TA.26118–26419)

This teacher further described a performance-based task that he had created based on students' interests:

> I think in Algebra 1, some students were researching the number of police killings and different errors, and they modeled that with a linear function to see how it actually increased over time. And they made a linear function to discuss, so like 10 years from now if [this rate] still keeps happening, [this is] the number of people [who] are going to be killed and it's like awful if they don't stop it. So that was real to them, and it was something that they wanted to learn more about through mathematics. (PINE.HS.TA.4005–4760)

The teachers also cautioned that designing performance-based tasks based on student interests is challenging because what students are interested in is "different across the board" (OAK.MA.LE.4442–5002). And because it's difficult to predict how students will respond, another teacher reflected how "it would be really hard to make a performance task that engaged and pleased every student in the state" (OAK.BL.BE.31765–32687). Yet, as one teacher expressed, "Have them choose a topic they're really interested in. . . . I've seen that kind of inoculate students from disengagement" (PINE.HS.TA.9826–11359).

Personalization. Fifteen out of 24 students (63 percent) reported that personalization increased their engagement in the performance-based task. More specifically, nine out of the 15 students who completed Task B (60 percent), expressed that the performance-based task that required students to calculate their maximum and minimum heart rates based on age (Task B) was more meaningful to students because it was *personal*, it affected their bodies and helped them learn more about their health. As one student described, "that's really important for me to know, so like not over exercise or not overextend myself, so I can stay healthy and continue to play sports" (MAPLE.CA.CA.10537-10752). This served to satisfy the students' personal motives or needs, which is what partly defines relevance. Another student related, "So I guess people are really fond of things that they can relate to like with heart rate, everyone has a heart rate, so it was kind of on the right track" (PINE.KB.FI.5505-6279). Thus, our initial hypothesis bore out; students who completed the performance-based task that was personalized to the students perceived the task to be more relevant to them and increased their engagement.

Seven out of eight teachers (88 percent) reported that student engagement was elicited when the study's performance-based task was personalized to the students.

As one teacher explained, “The personal made the difference, the fact that they were finding their own number of beats” (MAPLE.KI.MA.11334–12531). The same teacher also noted, “I think that they’re just sort of curious about things that have to do with themselves and their growth and what might happen to them . . . people, in general, we like things when they relate to us” (MAPLE.KI.MA.13999–15241).

Interestingly, three of the four teachers who administered Task B (the version intentionally personalized to the students), did not approve of how the study’s performance-based task had the students calculate a heart rate for a fictitious character, Ms. Jones. The teachers perceived this concept to be lacking a connection to the students, thus rendering the task less engaging. As one teacher related,

> In the Miss Jones, I think they were like, ‘Who is Miss Jones?’ I was like, ‘It’s just a community member.’ So I think if it’s for a real person, I think it could have had more engagement for them and they could relate, like it could have been me or it could have been my age or another teacher in the building or an actual community member. (PINE.HS.TA.16009–16776)

This teacher’s response emphasizes the importance of making performance-based tasks truly relevant to students through personalization and by incorporating students’ interests and prior experiences.

Authenticity

Analysis of interview data revealed the importance of authenticity to student engagement; it was the second-most prevalent strategy Likewise, teachers discussed for increasing engagement, appearing 109 times in the interview data. All eight teachers and 19 out of 24 students (79 percent) mentioned authenticity as it relates to improving engagement.

Real-world scenario or data. Thirteen out of 24 students (54 percent) discussed authenticity as a real-world scenario or a task that uses real-world data. For example, one student emphasized the importance of real-life situations and that “math is everywhere.” She explained that when we engage in everyday activities like cooking or driving we do not realize that we are doing mathematics, but that it would be helpful to know. She also advised teachers to make connections to the real world for their students: “If I were a teacher, I would want some of those [tasks] that connect to the real world” (OAK.SC.IS.14232–14945). Another student recalled a task she completed in a class where the teacher threw a basketball in the air to illustrate a parabolic path. She described this as an engaging task in which they predicted where the ball would land using graphs and their understanding of parabolas and quadratic functions (OAK.LM.AN.10028–10346).

Some students discussed the importance of real-world scenarios and also provided a counter-example of unengaging tasks that are not related to the real world or do not refer to real-world data or objects. One student explained that real-world scenarios are "easy to connect to," for example, one that included real animals. She asserted that an unengaging task might include fictitious animals (e.g., unicorns), where one might "try to find that animal and you can't because it's not real" (OAK.SC.IS.15213–15659). Another student called his math class "boring" because "we just talk and talk about the problems and that's it; we don't apply anything to the real world" (OAK.DI.FE.4902–5139).

Seven out of eight teachers (88 percent) mentioned how real-world situations and data engage students and create "authentic natural engagement for kids because [the task is] not devoid of context, it's not random, and they can see how it relates" (PINE.HS.TA.4005–4760). One math teacher discussed a project she saw during her student teaching experience at an urban high school. The teacher she observed created a project where students investigated data about police traffic stops to question bias in police activity. She contrasted this police traffic stop task, which utilizes authentic data, with a task that for instance is about "Billy makes a cake and the cake weighs this much" (OAK.MA.JA.16421–17305). She explicitly contrasted the authentic scenario and data with a potential math task about baking an imaginary cake. She explained why real-world topics and data sets are engaging for students.

> It's really engaging because it's a very controversial topic, and it's also something that's very real for a lot of our students and especially students of color. And I think that them being able to utilize and make arguments based on their skill set that they're learning in school is credible, and that's what's going to help in the real world. (OAK.MA.JA.16421–17305)

Another teacher described a task where students use exponential functions to examine the data of changes in rental rates in their city. He adds that this investigation of real-world situations "proves what they're feeling" about the gentrification of their community (PINE.HS.TA.27174–27786). Another teacher in the same school discussed how the authenticity of the task can garner engagement from her students. She reflected on her own learning experiences engaging in math problems about "'Jack and Jill: The Movie,'—who cares?!" She uses these experiences to create tasks that are authentic: "I made a problem about me buying Cheetos and not having enough money for nacho cheese to put on top, and all the kids were like 'I know what that means!'" (PINE.BA.KY.7058–7696).

Utility value. In addition to authenticity as real-world scenarios, authenticity can also be understood as providing *utility value* or being of use in the real world, such as paying bills or monitoring heart rate for health purposes. Fourteen out of 24 students (58 percent) mentioned authenticity as a utility value that improves their engagement.

One student mentioned how she would use what she learned in the study's performance-based task to save her life: "If I was running and then I found out that my heart rate is too fast, or at a maximum, and I'd try to stop it so that I don't die or something" (OAK.ON.CH.1038–1066).

Students expressed a desire to engage in tasks related to real life and to learn something that they can use in their future careers. Students mentioned wanting to be a construction worker, therapist, biologist, and doctor. Students also spoke disparagingly of tasks they thought would not have utility value for a future career. As one student said, "What if I want to be like a construction worker or something like that or just to paint houses, right? I don't need math. I don't need all this math just to learn how to paint the house" (OAK.LN.KA.5120–5844).

Likewise, teachers mentioned their attempts to make tasks engaging by connecting to situations in which the information is useful to accomplish something in the real world. For instance, a teacher described how he teaches the economics concept of compound interest to his students:

> I could make compound interest formula really boring, dry, and dull, but I just try to give good examples of that. When you go to college, there will be tables offering credit cards for free and you're going to spend a thousand bucks then end up spending sixteen hundred bucks and let me show you why. (MAPLE.KI.MA.16637–17779)

This teacher makes the topic of compound interest interesting and engaging for students, by making sure that students can actually use the information to their benefit when thinking about loans and credit cards.

Feasibility. A third understanding of authenticity was expressed by no students and three out of eight teachers (38 percent). A teacher who often mentioned his desire to make math class fun discussed authenticity in terms of checking to see if an answer is realistic. He described a task and added,

> I think it's engaging because they're making a prediction. I think that is a good way to have them predict, and it's fun too, especially when you can see in the real world alone on how close is my prediction, how close is my model. (OAK.MA.LE.14074–14535)

Another teacher discussed how students should use mathematics as a tool to examine health claims. She argued, "There's so many crazy health claims that are made, and ads and things like that like is that feasible or is that reasonable?" (OAK.NO.LA.17920–18770).

Authentic purpose or audience. No students and three out of eight teachers (38 percent) mentioned a fourth feature of authenticity: having an authentic audience or purpose. For instance, one math teacher discussed how she thought that her students might have taken the study's performance-based task more seriously because they knew that the task was part of a research study. She explained,

> I think their knowing in some ways that they . . . they were aware that they were doing it for the study. And I did say I'm going to look through them but this is not being graded and that didn't matter. That wasn't part of it. But I do think potentially the fact that somebody else was going to look at it might have mattered. (MAPLE.KI.MA.12533–13188)

We anticipated teachers mentioning student presentations to an authentic audience, but respondents did not mention this. However, student presentations to an authentic audience, such as students investigating the nutritional value of the school lunches and advocating for healthier options to a school board or school administrators, would offer a sense of authenticity and reason to engage in the project.

Some teachers mentioned tensions and challenges of incorporating various engagement concepts in the tasks they design. For instance, teachers discussed their efforts to make tasks both authentic and relevant or both authentic and collaborative. They discussed challenges and considerations of when one concept may have greater influence for students. A teacher described an activity in which she created a set of five tasks with real-world data, where students were able to choose one of the five tasks to complete. She reflected on students' engagement: "I think because they're all real-world, this doesn't have to be necessarily exactly co-aligned with what's going on in our students' lives" (PINE.BA.KY.19548–19991). Here she describes the (lack of) relevance of a task by mentioning how a task may be "co-aligned" with students' lives—that a task that is not relevant but is authentic can still be engaging to students. She argues that the authenticity of the task is of greater import than the relevance to garner student engagement in the task.

Another teacher further complicates the discussion of student engagement as it relates to authenticity, reflecting on tasks that her students have done that are completely inauthentic. She describes her students' engagement: "I've seen kids engage with things that have absolutely nothing to do with the real world. Just like we do puzzles and games like they have no application" (OAK.NO.LA.6847–7233). This statement highlights the importance of the engagement concept of higher order thinking skills, where a puzzle may be engaging by employing one's higher order thinking skills, yet be inauthentic insofar as it does not connect or have direct application to the real world.

Autonomy

Autonomy arose predominantly in teacher interviews. Overall, nine out of 24 students (38 percent) and seven out of eight teachers (88 percent) mentioned autonomy as it relates to engagement.

Open-endedness of tasks. Two out of 24 students (8 percent) and six out of eight teachers (75 percent) mentioned tasks being open-ended to allow for autonomy as a feature that improves engagement. The two students commented that open-ended tasks are "not boring," contrasting an open-ended task with a "closed" task that is "not interesting" and "boring." When asked about the performance-based task he was given as part of the study (Task A), one student said that he found it more engaging because there were multiple answers: "Multiple people had different ideas, which [animal] was bigger and what weighs more" (OAK.DI.FE.4392-4745). Another student mentioned that the variation of the equation and the answers increased engagement for her. When asked about the study's performance-based task, she explained,

> I found the fact that there were equations that varies. I thought it was very engaging because it was like you couldn't just ask your neighbor what they got; you had to work on it too. I could tell about the people at my table also worked a little bit harder. (PINE.KB.FI.1153–1525)

Tasks that are open-ended allow students more opportunities for autonomy because students have the ability to make cognitive, organizational, and procedural decisions, rather than engage in a narrow or overly scripted task.

Teachers also mentioned how an open-ended task may offer more opportunities for engagement for students. Six out of eight teachers (75 percent) mentioned open-endedness as a feature that improves engagement. Teachers mentioned students being able to be "creative" with "flexible" and "exciting" tasks that are open-ended. Such open-ended tasks invite students to "re-engage with the problem" and also allow opportunities for demonstrating "differentiated understanding" for students who may be at different levels of proficiency in the subject area.

One teacher elaborated her desires for her students and their perseverance and dispositions toward mathematics, and how an open-ended task may help foster positive attitudes about their ability in mathematics:

> I want them to be able to try it and get into it and do something with it even if they don't get it right and even if they don't finish it. They come out and they feel like "Oh I could do this," or, "I know that I can start this even if I don't know what's the wrong answer or right answer." (OAK.MA.JA.11758–12478)

Another teacher mentioned open-endedness as "not having a right or wrong answer" and how it provides autonomy to students, which improves engagement. She described a project she is currently doing with her students that she feels they are much more invested in: "I see kids more engaged than anything they've done in math class this year. It's just like an open-ended kind of answer. There's no right answer, just make it work" (OAK.BL.BE.9250–9689). She also mentioned that tasks that are not open-ended might result in students feeling "stuck in a box," whereas open-ended tasks allow for "five ways to do it and get the right answer," which led to students being "encouraged" and "more into it" (OAK.BL.BE.2712–3617).

Choice based on students' ability levels or desire for challenge. Six out of 24 students (25 percent) mentioned autonomy as it relates to ability or challenge. Students' discussions of choice as it connects to ability or challenge level relates to their desire to choose how much challenge they wish to engage in. Students also expressed an understanding that people are different in their choice of challenge. One student highlighted this understanding of difference when asked if he thought it was better to have choice:

> I think it's more engaging if you get an option because then they might engage . . . so they get the chance to read each scenario and then they can choose which one they would prefer to do or which one is more challenging to them. Because people have different mindset or different ways of going about things, so it might be different for everybody (MAPLE.CA.CA.8106–8462).

Students mentioned feeling "less stressed" and "not stuck" when they have opportunities to choose which task to engage in based on their ability level or how much they want to challenge themselves.

Three out of eight teachers (38 percent) also mentioned autonomy. They discussed how students need opportunities to make choices based on their ability level or how much they want to challenge themselves. One teacher expressed her enjoyment of watching students' engagement increase when given the opportunity to make choices in performance-based tasks based on how much challenge they wished to take on. Another mentioned how she uses "supported choice" for her academically heterogeneous class, providing choices of similar tasks for students; this practice ensures students are learning the intended mathematics content, but allows them to choose tasks based on their ability level (PINE.BA.KY.22096–22740).

Choice based on students' interests. One student mentioned choice based on interest. The student explained, "Most teenagers don't like being told what to do so that if they have a choice on at least something like the activity that they're doing, then it's more likely that they'll be more engaged and more focused" (MAPLE.AB.SI.9242–9490).

Two out of eight teachers (25 percent) expressed similar sentiments. One mentioned how she uses choice on a regular basis in her classroom to garner student engagement. For instance, she described giving them choices of which tasks to complete on an exam, as well as letting students choose their own seats in class, rather than assigning them. She sees that students are more engaged in her class when she allows them to make choices based on their interests (PINE.BA.KY.20620–21001).

Choice based on students' desire to socialize. Students' opportunities for autonomy also arose when allowed to make choices about who to work or sit with and whether or not they should work in groups. One student mentioned choice as it relates to socialization. The student, when asked about her preference of working in a group or alone, discussed how she wanted to be able to choose:

> I think either [group work or working alone] is really useful [depending on] how many extroverts versus introverts there would be in a classroom. So I think having the option of being able to work with a partner would be very useful in a classroom but not to force it on people. (MAPLE.PE.ER.6335–6594)

Three out of eight teachers (38 percent) discussed students' choices as they related to socialization in terms of allowing them to choose where to sit rather than creating a seating chart. One teacher also mentioned allowing students the freedom to work alone or ask another student when they desired help or wanted to consult with someone else. Overall, teachers emphasized opportunities for student autonomy much more than students did. This is perhaps not surprising, as students are accustomed to classroom structures where teachers make decisions for students—where to sit, what to do during class, what assignments to complete outside of class. Traditional assessment formats are quite narrow and do not offer many opportunities for students to exercise autonomy. However, performance-based tasks, both those included in standardized exams (e.g., the Smarter Balanced Assessment Consortium exam) and classroom-based projects, offer greater possibilities to open up tasks that allow students to make organizational and cognitive decisions, and thus increase engagement.

Collaboration

A majority of students and teachers perceived collaboration as a strategy for increasing student engagement in performance-based tasks. Six out of eight teachers (75 percent) and 14 out of 24 students (58 percent) held this view. Specifically, students and teachers viewed collaboration as engaging because it afforded opportunities to get help from peers, opportunities for sensemaking, and opportunities to socialize.

Help from peers. Fourteen out of 24 students (58 percent) expressed that collaboration is engaging because it allowed students to get help from a partner or group mate when they were stuck or did not understand how to do the work. As a student explained,

> For me, it's easier to work with a partner. If I mess up, I have someone to work with to correct me when I get it wrong and show me what I did wrong. . . . A partner [is better than working with a teacher] because a teacher they are going to help you, but there are many other students in the class, so a teacher can't just stay with one student. So it's better to be with a partner instead of being by yourself and it is better than having a teacher who's going to help you for a little bit of time and then go to the next person. That throws you off track, and you'd still be confused, so it's better to have a partner there for you. (PINE.TH.DE.1573–2347)

Another student shared a similar sentiment:

> I like working better in groups because I get to listen to my partner's ideas and kind of see how they solve the problem and help each other. And when it's independently, it is just kind of up to you to know or guess when you don't know. (SPRUCE.LO.JE.LA.JI.9443–9702)

Students who shared this perspective also tended to view collaboration not only as a way to get help from a peer, but also to ensure that their answers were correct. When asked why it was more engaging to work with others, one student replied,

> Because when you work alone at some point you get slowed down. You slow down. You don't know what else to write down. . . . I don't feel engaged because I don't have anyone to communicate my ideas, to share my ideas. Maybe when you share an idea and the other person says, "You're somewhat right, but you're wrong in this part." And then they put their opinion in the part you were wrong about, and then you get the right answer. (PINE.TH.YA.3441–4166)

Another student expressed the same sentiment:

> Because they're just bored just doing their own work and like, "It's boring." They don't feel connected to the class. They're just listening and writing. But if there's somebody else, you could talk to them about what you're doing and ask them, "Oh is this right?" And I'm like, if you're just sitting there waiting for the teacher to come or you're raising your hand, it's better when you talk to somebody. You know there's somebody like next to you who you could talk about the work, if you're right or wrong. (OAK.DI.FE.13663–14845)

Two out of eight teachers (25 percent) also saw collaboration as a way for students to learn from one another. One teacher described group work in this manner, "I think the go-to is like group work because they know that they've been conditioned to know that it's okay to ask for help if they don't understand something" (SPRUCE.LE.JA.20683–20845). The other teacher explained,

> I don't really ever lecture. Everything is kind of a conversation but we do a lot of things that are whole class conversation. And so I think it's natural for them when they go into a small group to kind of continue that conversation. I also think there's enough variance among the skill levels of the kids in this particular class so that even though the groups are completely random, I just number them off as they walk in the door, they do draw on each other for who seems to be stronger. (MAPLE.KI.MA.3465–4651)

As demonstrated in their quotes, these two teachers expect that the students will use collaborative groups to ask each other for assistance.

Sensemaking. Only one student described collaborative groups as a way for students to make sense of the math concepts and deepen their understanding by asking each other questions, pushing each other's thinking, and challenging each other. When asked whether the performance-based task the students did for this study would have been more engaging had they been allowed to work together, one student replied, "Yeah, because we could have asked each other questions, like tested each other's thinking and suggested what could have done to do those problems" (SPRUCE.WU.JE.1063–1321).

Five out of eight teachers (63 percent) expressed the value of sensemaking. As one teacher explained,

> I think having [performance-based tasks] as a group is helpful because they bounce ideas off each other and they can challenge each other, like explain "Why are you doing that, I don't understand?" Then they have to defend their choices or if they think they're right they were like, "No, no. I need to convince you that I am right." This is something to a group activity that makes it slightly more engaging I think. (OAK.BL.BE.3619–4088)

Another teacher related,

> I think that in groups, it often looks like students checking each other's thinking and work, right? So it can be like, "Oh, how did you get that?" Or, "I don't understand that. Can you explain that a little bit more?" (PINE.HS.TA.1462–1818)

Sensemaking requires students to talk and interact with each other in a reciprocal fashion whereby students ask questions and build on each other's ideas to deepen their understanding. These productive conversations may shift all of the participating students' thinking, rather than simply allow one student to help another student get the answer.

Socialization. Five out of 24 students (21 percent) talked about partner or group work as opportunities for students to socialize or talk with classmates, but—unlike with getting help or sensemaking—without a learning focus in mind. Instead, for these students, socializing served as a way to build relationships between students, encourage participation, and make the math period pass more quickly. As one student observed,

> Nobody likes to work alone. . . . Being able to talk to someone else. Yeah, because that's what happens when you're in groups, most of the time you go off topic and talk about something else that happened. So I guess that's why people want to work in groups so that they can actually talk more about stuff. (OAK.LN.KA.2411–3570)

For this student, group work provided her with opportunities to engage socially with her friends. Another student offered, "It's good to work in a group because it makes the relationship between all students better and then they're more comfortable in class" (OAK.DI.FE.8937–9376). Another student shared that group work was more engaging than working independently because it made the time go by more quickly. That student related,

> I feel like working as group and partner is quicker than being alone . . . because we talk instead of just being quiet. . . . [Because] being surrounded in a room like in a quiet room that feels weird, but when you're talking to somebody time goes by quick and the work goes by quick. (PINE.KB.ROG.1862–2482)

Three out of eight teachers (38 percent) also talked about collaboration increasing student engagement from a socialization point of view. One teacher reported that the absence of collaboration was disengaging for students. When asked what was disengaging about the study's performance-based task that her students completed, she stated, "The solo portion of it, the fact that it's individual. Yeah, that's definitely an automatic disengager for some kids like they're just not going to do something by themselves" (OAK.BL.BE.20799–20989). Another teacher explained that collaboration was engaging because

> they're talking with each other. And I think that math is very isolating even if you think about where you go with it, in your master's and your PhD in math, like you're just stuck in a cubicle trying to solve

> things. So personally, I really try to engage them by making them more community-based activities. . . . We do a lot of pair work and a lot of group work. (OAK.MA.JA.2883–3477)

Although the majority of students and teachers perceived collaboration as a way to increase student engagement, six out of 24 students (25 percent) and one teacher held a dissenting view. Specifically, these students expressed a preference for working independently and spoke to the downsides of collaboration. As one student related,

> It depends on who I'm with because if it's a distracting person then I would feel like I'm doing all the work. . . . But I prefer when it comes to tests and everything to do it on my own because then I don't have to constantly say, "Oh yeah, did you get this answer for this one, or do you want me to help you with this?" I can just do it myself. I can push through it smoothly, and then I'm done and I don't really have to worry about what everybody else is doing. (OAK.SC.IS.8502–9391)

For this student, collaborative group work put a level of responsibility on her that she did not want to bear. She did not want to have to worry about how her peers were doing on the task. Other students expressed similar views, such as,

> I prefer working alone just because normally when I work with other students, they don't really engage. So it's more like I'm doing all of it by myself. So I like doing stuff by myself knowing that I know what I'm doing and then get the credit for it. (OAK.ON.CH.9747–10720)

When asked what he meant by "they don't really engage," he explained, "So like conversation with other people or they just don't understand so they don't do it" (OAK.ON.CH.9747–10720). Students who responded in this manner perceived collaboration to be disengaging because working with other students who talk off-topic or do not understand the work makes the task much harder than doing it independently.

The sole teacher who shared a negative view of collaborative socialization acknowledged that there were costs and benefits to collaborative group work. The downside to group work is that it can highlight the varying skill levels in the class and can have negative effects on students' math identities and motivation to learn. As the teacher related,

> With this question, What is the equation for the line you drew? I think that what's happening right now in my class is that there are some kids who know how to do all three of the steps and some kids who know how to do just one of those steps. And then this socio-

> mathematical divide starts to happen, and I think that that's dangerous to play around with. I'm still wrapping my head around that in what's the better cost or benefit of groups versus individual learning. (SPRUCE.LE.JA.22621–23078)

For this teacher, her conception of a "socio-mathematical divide" makes her cautious of the benefits of collaboration.

One student's experience mirrors the cost of group learning. She reported that her favorite class in school was one where the teacher provided anonymity to students for answering questions. As she explained,

> Well, we just started, but like if she asks us a question or something, she has a classroom set up on Google or something. And we can text her from our phone our answers, and it goes up on the board. But it's like anonymous, so no one knows who got it wrong or something. That's good because most people don't, like me, I don't like to raise my hand in class especially if I know that I got the answer wrong. And then the teacher would call me, and I have the answer wrong and everybody just sees that I don't have the answer. I hate that. So I like how we get to like text our answers to the classroom and then it goes up on the board, but nobody knows who it's from so that's cool. (OAK.LN.KA.8305–9046)

For this student, the fear of public exposure of getting an answer wrong weighs heavily on her and collaborative group work could emphasize the disparate skill levels among and between students.

Higher Order Thinking Skills

Thirteen out of 24 students (54 percent) and all eight teachers mentioned higher order thinking as improving student engagement. This study's two performance-based tasks were created to offer students opportunities to engage in higher order thinking. Both task versions required students to synthesize information, apply the content to novel problems, draw conclusions, and explain their thinking. In interviews, students referred to features of the task that elicited their higher order thinking skills, and teachers mentioned their efforts to elicit students' higher order thinking in the activities they create and assign their students, rather than asking students to engage in lower order thinking skills, such as recall or memorization.

Tasks that are challenging but doable. Students and teachers referred to tasks that engage higher order thinking skills as challenging but doable. Nine out of 24 students (38 percent) mentioned this quality in their interviews. One student discussed how he is more engaged when the task is "hard" for him. He reflected on the task and said, "I wanted to figure it out, so I was just like how do you do this stuff and then I just want to finish it" (OAK.BB.RI.762–1327). One student even suggested that he would make "this part a little bit hard so people will try harder on doing this" (PINE.KB.ROL.1477–1561), indicating that challenge fosters engagement. When asked about how challenging a task should be, many students said it should be "in the middle," at the right level of challenge to the individual student.

Six out of eight teachers (75 percent) also discussed how tasks should be "challenging enough" and how they strive to find the "fine line between too easy and too hard." One teacher mentioned the tension between making tasks "doable and challenging at the same time" (MAPLE.KI.MA.20576–21596). Teachers related how they gauged their instruction to challenge students at appropriate levels, and that "how deep" they got into the math varied by class.

Multiple representations, solutions, or solution strategies. Tasks that elicit higher order thinking skills also present students with multiple representations and allow for multiple solutions or solution strategies.

Five out of 24 students (21 percent) mentioned this multiplicity in their interviews. One student described a project she is currently working on in her Algebra 2 class. The project involves students creating pictures using functions and specified domains of each function. They have been using Desmos (a graphing calculator) to help them graph each function. She explained that she liked it because you can "play" with the functions: "You could make a lot of graphs and then choose what you want as the topics for each day" (OAK.SU.TA.9842–10510). Another student indicated that students would be more engaged if they had opportunities to demonstrate their understanding in multiple ways, because "If it's a bunch of different topics then they get a chance to actually show where they have the most knowledge" (OAK.ON.CH.4689–6071).

Six out of eight teachers (75 percent) mentioned this quality, and did so much more often than students did, because teachers in this study tended to consider multiplicity when creating and selecting tasks for their students. One teacher explicitly noted that "multiple access points are really important" (OAK.MA.JA.14454–16203). Another described an activity she created for her students that illustrates how multiple access points and multiple representations are embedded in the task. The Algebra 2 activity involved teaching students about the unit circle (a circle with a radius of one), where students are asked to create a unit circle in the real world:

> One group made a perfectly round cake and then decorated it as a unit circle. Another group actually made a round Ping Pong table with a net right on the x axis and painted it all like the unit circle and the certain angles. (OAK.MA.LE.25562–26379)

She emphasized that the multiple "correct" answers allow students to be creative.

Self-Assessment

In relation to the other engagement concepts, a smaller number of students and teachers spoke about the use of self-assessment practices in performance-based tasks as eliciting engagement. In addition, the majority of the student and teacher responses were prompted. That is, students and teachers had been asked explicitly if the use of self-assessment practices in performance-based assessments would increase student engagement. Nine out of 24 students (38 percent) and one teacher reported that including self-checks in performance-based tasks would be engaging and helpful to students. In contrast, two out of eight teachers (25 percent) held a dissenting view. They expressed that the use of self-check reminders would *not* be of value since, in their experience, students tend not to engage in self-assessment practices even when told to do so.

Usefulness of self-check reminders. Four out of 24 students (17 percent) expressed that self-check reminders are *useful* because they provide notice to the students that they should go over their work. As one student noted, "I think putting self-checks are good because it serves as a reminder. Because me personally, sometimes I forget to check my work, but it doesn't really make it engaging to put it. It's just a helpful reminder" (SPRUCE.LO.JE.LA.JI.13124–13331).

Another student explained, "I think it's helpful because I feel like if those [self-checks] didn't pop up, you wouldn't go back and you wouldn't check your work, you'll just continue" (OAK.SC.IS.12084–13567).

Effect of self-check reminders on performance. Four out of 24 students (17 percent) also reported that self-assessment practices *help students do better*. Through self-checks, students are able to catch small errors and mistakes and thus have better performance. As one student expressed,

> I think [self-checks] will be engaging because they'll end up more like focused on the details because they'd be like, "Okay, let's see if I actually did this right. Let's see if I put the negative sign here and check over my work." I think it will just make them be more cautious of what they're doing in the equation and the problem-solving. (MAPLE.AB.SI.12229–13126)

Similarly, another student related,

> I think it's helpful because for me. Like when I do tests, I just sometimes forget to go over my work. And normally, when I don't go over my work, that's like when I miss the easiest things. So when I see stuff like that I'm like, "Yeah, I forgot to add that." (OAK.ON.CH.11138–11410)

Metacognitive engagement. Two out of 24 students (8 percent) shared that self-assessment practices should be included in performance-based tasks because they engaged students in metacognitive practices. *Metacognitive practices* allow students to better understand what they know and do not know and to check for gaps in their understanding so that they can self-initiate strategies to improve their learning.

When asked why they would advocate for including self-checks in performance-based assessments, one student replied, "Because they would know what level they're at like, 'I don't understand this, I'm going to ask the teacher' or 'I'm going to ask my peer about the work'" (OAK.DI.FE.12972–13662). The other student explained,

> It gives the person a time to actually reflect and maybe think about or go back to think about what makes sense in the problem and how they actually did and how they came to their answers and if their conclusions actually make sense. (MAPLE.CA.CA.11415–12337)

The only teacher to share this view expressed that self-checks are

> a great way to assess understanding . . . at the end of the day, what you're trying to teach them is to be able to have enough confidence and say, "This is wrong and I know it" . . . it drives me nuts when kids who totally get it conceptually will come up with an answer just because they're being quick or sloppy and they're like, "Oh the Tesla was going 1,400 mph." And [I'm] like, "Didn't you just stop to think about it for a second that there's absolutely no way that the Tesla was going 1,400 mph?" So it's kind of like because that, at the end of the day, is what you want them to be examining and thinking about and being critical of. (OAK.MA.LE.30596–31841)

It is interesting to note that the two students and the one teacher who spoke of metacognitive practices were the only ones whose views reflected the notion of self-assessment that is described in the research literature, that is, that self-assessment practices allow students to be reflective and monitor their understanding and learning. In addition, of the students who expressed that they see the value of incorporating self-checks into performance-based tasks, they did not all talk about the performance benefits for students (e.g., "Through self-checks I catch mistakes"). It is, of course, possible that students who spoke only of self-checks as being useful reminders may experience performance benefits too, but because they did not make that direct connection, it is unknown whether they perceive that self-checks improve their performance.

Lack of engagement with self-check reminders. Two out of eight teachers (25 percent) reported that self-assessment practices are not engaging because students tend not to do them. As one teacher commented,

> I feel like kids just don't do it because it's on the paper, like if it's just "Check your work," they just don't do it. They just move on because like, "No, I don't really need to check my work." Well, most people don't want to check their work. So there has to be a reason again to check your work. (SPRUCE.LE.JA.27083–27914)

Instead, the teachers suggest that providing an authentic self-check process within a performance-based task is a better way to ensure that students engage in self-assessment practices. A teacher related,

> But if it's just a reminder, it doesn't tend to work. So if it's the rubric and I say to them, "Have you gone through your rubric? Have you made sure that you have all the pieces?" That is not as compelling as within the task itself, you must check these things. (MAPLE.KI.MA.34387–35750)

The other teacher explained,

> I think one teacher at school, a physics teacher, did a really great project where they had to build projectile cannons and the thing that was being projected needed to go over the volleyball net in our gym and land on a target. Well, you better check your numbers because there's a goal, like you have to get it in here, but checking your work for the sake of checking your work that's like asking an auditor to recheck their work and only auditors like to do that. (SPRUCE.LE.JA.27083–27914)

From these two teachers' perspectives, including a self-assessment reminder in a performance-based task does not increase student engagement. Rather, what does increase engagement is having an authentic reason to check over their work, a reason that is embedded in the task. Students are impelled to correct their work when the outcome or product of the task does not perform as intended. This natural consequence will do more to elicit engagement than including a separate question that asks whether they have checked over their work.

Discussion

In the present study, we examined students' and teachers' conceptions of what makes performance-based assessments engaging for students. We found evidence that students and teachers recognize and value the six concepts of engagement found in the literature: relevance, authenticity, autonomy, collaboration, higher order thinking skills, and self-assessment.

The Six Concepts as Engagement Strategies

Relevance and authenticity. Interview data reveal that relevance and authenticity were the most mentioned strategies for increasing student engagement. Relevance was mentioned by all 24 students and all eight teachers. The data indicate that respondents conceptualize relevance as relating to *prior experience*, described as something the student has experienced or seen previously, something they are familiar with; *interest*, a student's desire to know more about a particular topic or a topic for which a student may have a passion; and *personalization*, as having to do with the student's own person, body, private life, or relationships. Authenticity, the second-most prevalent strategy (mentioned by 19 of the 24 students and all eight teachers), was described by respondents in four ways: being a *real-world scenario* or task using *real-world data*; having *utility value* to accomplish something in the real world; having *feasibility* in the real world; and having an *authentic audience or purpose*.

The various features of relevance and authenticity are helpful to assessment developers, educators, and policymakers because they highlight how these engagement concepts actually matter to students. In addition, they underscore the fact that these features can be incorporated into the design of performance-based tasks. For instance, a task can be made more engaging by relating it to something personal for students, e.g., their own personal health, thus increasing the task's relevance. A task can be made more engaging by ensuring that it utilizes real-world data, and it can include an authentic purpose or audience. These revisions to a task are feasible in the current testing paradigm, and the creation of more innovative assessments will offer greater possibilities to incorporate these features.

Collaboration and higher order thinking skills. Collaboration was also mentioned often by 14 of the 24 students and six of the eight teachers as a feature that increases engagement. Respondents viewed collaboration as engaging because it afforded opportunities for *help from peers, sensemaking, and socialization*. Tasks that call on students' higher order thinking skills were also frequently mentioned (13 of the 24 students and all eight teachers). Respondents viewed tasks that elicit higher order thinking skills as *challenging but doable*, and as having *multiple representations, solutions, and/or solution strategies*.

It is important to note that the students did not specify what they meant by "challenging." Thus, a task that is perceived to be challenging may not actually require the use of higher order thinking skills such as analyzing, interpreting, or manipulating information. Instead, the task could be perceived to be challenging because the content is novel or because it must be completed in a short amount of time. However, the study's performance-based tasks were designed to elicit students' higher order thinking skills. Both task versions required students to synthesize information, apply the content to novel problems, draw conclusions, and explain their thinking. Thus, it is also possible that what the students were responding to as challenging may be that the task required them to go beyond simple recall and insertion of numbers into known formulas. The responsibility lies with educators to ensure that for students, "challenging" becomes synonymous with "engaging" in complex tasks that require interpretation, analysis, synthesis, evaluation, and application rather than with the simple notion that something is difficult.

In order to increase student engagement, a task can incorporate higher order thinking skills by providing multiple access points into the problem and providing students with multiple ways to demonstrate and represent their knowledge and skills. In large-scale assessments, real-time collaboration may be more challenging to incorporate. However, test creators can build scenarios that place students in collaborative situations (e.g., working with four classmates to develop a proposal for a new class). In addition, with technological advances that allow assessments to be taken online, computer simulations can be used to create a virtual environment where students collaborate to solve a particular problem. This is, in fact, what has been added to the new Programme for International Student Assessment (Ward, 2015).

Autonomy and self-assessment. The concepts autonomy and self-assessment were mentioned less often than we expected. Autonomy was mentioned by nine out of 24 students (38 percent) and seven out of eight teachers (88 percent). Discussed predominantly by teachers, autonomy was described in the following ways: *open-endedness of tasks* that allow students to make decisions; *choice based on students' ability level* or how much they wish to challenge themselves; *choice based on students' interests*; or *choice based on students' desire to socialize*. Only nine out of 24 students (38 percent) and one teacher mentioned self-assessment as an engagement strategy, discussed as *usefulness of self-check reminder*s to prompt students to go back and check their work; *self-check reminders effect on student performance* as opportunities to help students do better to catch small mistakes; and as *metacognitive practices* that allow students to better understand what they know in order to self-initiate strategies to improve learning. However, the *lack of engagement with self-check reminders* also came up in interviews. Two out of eight teachers (25 percent) suggested that students need an authentic reason to go back and check their work, such as a bridge made of straws that would collapse if the right calculations were not made, rather than using a simple self-check prompt within the task.

Although these two concepts were not predominantly mentioned in student and teacher interviews, incorporation of these features is important for improving student engagement in assessments. For example, performance-based tasks should be designed so that the tasks are open-ended and provide students with opportunities to make cognitive, organizational, and procedural choices. In addition, the self-assessment feature could be incorporated into performance-based tasks by requiring students to explain or justify their answers. The process of explaining an answer engages students in metacognitive practice and in doing so students may catch missteps and gaps in their understanding.

Recommendations

The data from the study both confirm the importance of the six concepts of student engagement and add an understanding of the nuance and features of each. For instance, open-ended tasks may increase opportunities for students to exercise their autonomy as well as engage in higher order thinking skills. A task about students' personal health may be simultaneously relevant and authentic because it is personal to the student, making it relevant, and includes real-world data about health statistics or recommendations, making it authentic. However, a task may be authentic, such as one that investigates global warming, but not relevant to the student if not familiar, related to the student personally, or connected to the specific individual student's interests.

In addition, the study indicates tensions between the concepts as indicated by one teacher who highlighted the costs (and benefits) of collaboration. Another teacher underscored the highly varied nature of relevance being specific to each individual student.

Still, the six concepts offer multiple ways to increase student engagement in assessments. A single task may not be able to incorporate all six concepts, but it may score "high" on authenticity to compensate for being "low" on relevance, especially given the context-specific and individual nature of relevance as different for every student.

Based on our analysis, we offer the following recommendations to educators, assessment developers, and policymakers for ways to increase student engagement in performance-based tasks.

Recommendation 1: Relevance. Increase task relevance for students by making connections to students' lived experiences and interests, or through personalization. The task should create a "need to know" for students and give them a reason for doing the task. When designing the performance-based task, consider the following questions: Why would the task matter to the students? How is the task connected to the students, their experiences, or their interests? How does the task build students' background knowledge in order to provide access to the content?

Recommendation 2: Authenticity. Create authentic tasks for students that emphasize real-world connections and require students to solve real-world problems. Highlight the task's authenticity by ensuring that the task has utility value for students so that they see that the learned content or skill will be of use to them beyond school. Consider the following questions: How does the task emphasize real-world connections? How is the task structured so that students engage in real-world problems that are encountered in work and everyday settings? In what ways does the task provide utility value to the students?

Recommendation 3: Collaboration. Incorporate opportunities for students to collaborate in pairs or small groups to increase engagement in the task. In low-stakes assessments, provide opportunities for students to share ideas, answer each other's questions, and engage in sensemaking. In higher-stakes assessments, include opportunities for students to collaborate through a classroom activity that is completed before launching into independent work. In addition, use simulations or context scenarios that place students in a collaborative setting to create a virtual collaborative experience. When designing the task, consider the following question: In what ways does the task incorporate collaborative opportunities for students?

Recommendation 4: Higher order thinking skills. Emphasize higher order thinking skills in the tasks by requiring students to analyze, interpret, and manipulate information to solve the problem. In addition, ensure that the tasks have multiple solutions or involve various solution strategies. Consider the following questions when designing the task: To what degree does the task involve analyzing and interpreting information to arrive at a conclusion? Is the task structured in a way to allow for multiple solutions or solution strategies to be employed?

Recommendation 5: Autonomy. Support student autonomy within the task by providing opportunities to make choices that are consistent with students' interests. Create open-ended tasks that afford students cognitive, procedural, and organizational choices. Consider the following questions: How is the task structured to allow students to make choices consistent with their interests? In what ways are students afforded opportunities to handle and manipulate ideas and materials in the task? Does the task structure provide a range of possible solutions?

Recommendation 6: Self-assessment. Incorporate self-checks or prompts within the task to engage students in the self-assessment process. Require students to explain or justify their answers or use reflection questions so that they engage in metacognitive practices and assess their own learning. Alternatively, design the task such that the task's outcome or product will provide an immediate and authentic self-check to students (e.g., does the robot actually work? does the bridge made of straws hold up?). When designing tasks, consider the following questions: In what ways does the task provide opportunities for students to self-assess their performance? How does the task engage students in metacognitive practices?

Conclusion

We hope that this study informs and guides educators, administrators, and policymakers to develop assessments (both large-scale assessments and classroom assessments) that fully engage all students. The development of standardized assessments does not have to come at the expense of student engagement. This study highlights the engagement considerations that both students and teachers recognize are possible within an assessment context. The time is ripe with opportunity—especially with the introduction of the Every Student Succeeds Act, which explicitly specifies assessment provisions such as performance tasks that may offer opportunities to increase student engagement (ESSA, 2015). We believe these engagement considerations will gain traction because of their wide applicability to large-scale, school-, and classroom-based assessments to increase achievement for all students.

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Appendix A:
Performance Task A

Name:______________________

Per:______ Date: ____________

Do Now# **: Animal weight**

A.

Lightest			**Heaviest**

B.

Seconds	**Number of beats**

Seconds	**Number of beats**

Seconds	**Number of beats**

On average, my heart beats ___________ for every

____________________ that goes by.

Name:______________________

Assn#   :Heartbeat Task (version A)   Per:______ Date: ____________

Task Scenario

In this task, you will develop a model of the relationship between the body weight and pulse rate of animals. You will examine additional data to evaluate the initial model.

A study states that the relationship between an animal's pulse rate and body weight is approximately linear. The study data are below.

The Task Part 1: Animal heart rates

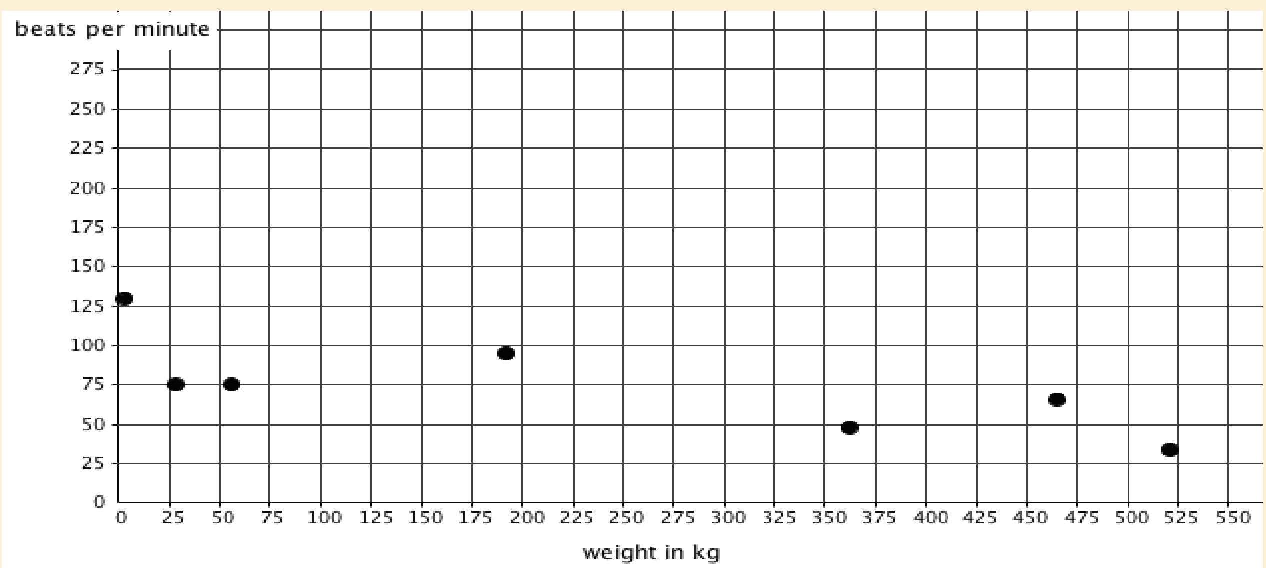
Table 1. Average Body Weight and Average Pulse Rate of Seven Animals

Animal	Average body weight (kg)	Average beats per minute
Cat	3	130
Goat	28	75
Sheep	56	75
Pig	192	95
Ox	362	48
Cow	465	66
Horse	521	34

1. Draw a line of best fit for the graph below.

2. What is the equation for the line you drew?

3. What does your slope mean in this context?



4. A) Based on your equation, what would be the average beats per minute for an animal that weighs 6000kg?

B) Explain your answer for 4a) and if it makes sense in this context.

Part 2: More information

5. The weight and heart rate of two smaller animals are given in the table below.

Animal	Average body weight (kg)	Average beats per minute
Guinea Pig	1	250
Rabbit	2.5	265

a) If the previous table and graph included these animals, would this change your equation for part 2?

b) How do you know?

Appendix B:
Performance Task B

Name:______________________

Per:______ Date: ____________

Do Now# : Heartbeats

A. My resting heart rate

Seconds	Number of beats

On average, my heart beats ___________ for every

____________________ that goes by.

Seconds	Number of beats

How did you and your partner count and figure out your beats per minute?

Seconds	Number of beats

B. What does *maximum heart rate* mean?

What does *target heart rate* mean?

Name:______________________

Per:______ Date: ____________

Assn# **: Heartbeat Task (version B)**

Heartbeats Performance Task Card

Setting

Your community is organizing an exercise challenge day to motivate people to exercise more as a way to improve their health. You have volunteered to help people of all ages (children, teenagers, adults, and senior citizens) learn about their maximum, and target heart rates so they will know how to exercise safely.

Your Task

In this task, you will first review the different types of heart rates and evaluate data to learn more about the relationship between heart rate and age. Then you will complete your own and help an adult complete an Individual Exercise Card.

Key Terms

Below are definitions of the two types of heart rates. These distinctions are important to understand so that participants at the event do not get injured or dizzy during exercise.

Maximum heart rate	The highest number of beats per minute an individual can achieve without causing severe problems to the body. This rate depends on age.
Target heart rate	The number of beats per minute that burns calories and is still safe for your body. **This number is 50% to 70% of a person's maximum heart rate.**

Equations

In your research, you learn that there are two established equations used by doctors to help people of different ages estimate their maximum heart rates. The original equation was developed in 1970, and then revised in 2001.

Table 1. Equations for Calculating Maximum Heart Rate

Original equation (1970):

Maximum heart rate = 220 – Age

Revised equation (2001):

Maximum heart rate = 210 – (.5 x Age)

Assn# **: Heartbeat Performance**

Name:______________________

Per:______ Date: ____________

Heartbeats Performance Task Card

1. Use both equations in Table 1 to estimate your maximum heart rate, in beats per minute.

a) Your age: _______

b) Your maximum heart rate based on Original equation: ______________ beats per minute

c) Your maximum heart rate based on Revised equation: ______________ beats per minute

2. Circle which of the three statements below bests describes the relationship between age and maximum heart rate as age increases? Use either equation in Table 1 to help you decide.

   As age increases, maximum heart rate increases

   As age increases, maximum heart rate decreases

   As age increases, maximum heart rate remains the same

3. Explain your reasoning for selecting your answer to Question 2. Use words and numbers in your response.

4. Compare the two equations you just used. Explain whether the two equations give similar results of maximum heart rates for people of different ages. (*In your response, include specific evidence to support your response by finding the maximum heart rate using both equations for at least two different ages*)

Now that you have completed your research about heart rates, you can complete the exercise card.

- Use Revised Equation in Table 1 to find the maximum heart rate
- From the Key Terms, recall that the *target heart rate* is equal to the range between 50%-70% of a person's maximum heart rate.

5. In Table below, enter the information for yourself and for Ms. Jones, a community member (age 49).

Name	**Age**	**Maximum heart rate**	**Target heart rate**
You			to
Ms. Jones	49		to

6. Explain how you calculated the *target heart rate range* for Ms. Jones in Question 7. Use words and numbers in your response.

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