Traditionally, assessing and grading students in science has been an exercise centered around points and percentages (Feldman, Kropf, and Alibrandi 1989; Proitz 2013). However, with the introduction of the NGSS and the need to revisit grading practices stemming from the COVID-19 pandemic, an increasing number of schools have begun to revise their grading practices (Guskey 2021; Zalaznick 2022). One of these alternative assessment and grading systems is known as standard-based grading (SBG), which encompasses three deviations from traditional grading and assessment (Townsley and Wear 2020).

- The grade book reports learning goals, closely connected to the NGSS, rather than an assortment of points accumulated from various tasks and assessments, points, or percentages (Figure 1).
- The assessment and grading structures provide multiple opportunities for students to demonstrate what they have learned.
- Homework and formative assessment are repurposed as ungraded practice.

Recent research suggests that when grade books transparently display students’ current understanding, students have a better understanding of their knowledge and skills and can continue to improve them (Guskey 2020; Noschese 2011; O’Connor, Jung, and Reeves 2018; Wilcox 2011). This approach is consistent with the NGSS and its goal to “actively engage [students] in scientific and engineering practices and apply crosscutting concepts to deepen their understanding of the core ideas in [science] (NRC 2012, p. 10).
However, many myths and barriers accompanying these alternative science grading practices can make shifting toward SBG difficult. The purpose of this article is to address these myths and provide strategies for effectively implementing SBG in the science classroom.

**Myth 1: “The real world isn’t like this.”**

Within the typical science classroom, if a student does not do well on a test, the score is permanently recorded in the grade book. The only way for the student to improve his/her grade is to do better on the next assignment, lab, or assessment. In an SBG classroom, students are provided with multiple opportunities to demonstrate their understanding of the course standards. A common myth is that students’ ability to not be penalized for late work or to redo a lab or take another version of a test is “not like the real world.” The “real world” does not often combine communication of consequences and performance. While consequences are important for students to understand, SBG does not interweave these non-achievement factors with communicating students’ understanding of the science standards. Non-achievement factors can be reported separately and not impact students’ grades. Similarly, being late for a dentist appointment may require paying a fee; however, the dental practice does not change the assessment of my teeth.

In other situations, the “real world” is tolerant of, and even expects, mistakes to happen. It is also important to note that physicians-in-training spend considerable time honing their skills and making mistakes with cadavers before being permitted to practice on real humans. In engineering, engineers make iterations to optimize their designs (NGSS Lead States 2013). Similarly, scientific knowledge can be revised in light of new evidence (NGSS Lead States 2013, Appendix H). As an example, scientists recently found the universe’s background starlight is twice as bright as scientists expected (Kruesi 2022). Given many STEM fields demand an approach of continued learning, SBG can model a similar approach to continued learning.

**Myth 2: “Grading this way will decrease the rigor of my science classroom.”**

This myth questions if the science classroom will be as rigorous and if students will learn as much with SBG. Part of the source of this myth is connected to problematic definitions of “learning” and “rigorous” (Kruse, Wilcox, and Easter 2022). Wagner (2008) notes that rigorous learning needs to be redefined from “retaining lots of information the first time” to skills such as critical thinking, problem-solving, collaboration, curiosity, and imagination. Under this revised definition of rigor, a science SBG classroom holds up very well. The purpose of grading in SBG is to communicate what students know and can do (O’Connor 2018). When students receive effective feedback in science, students can use the feedback to improve (e.g., Edgerly, Wilcox, and Easter 2018). Instead of just moving on to new content, students in an SBG system are expected to put in the work to develop their knowledge and skills.

Additionally, there is no more “fluff” such as extra credit, completion points, and participation points that artificially inflate students’ grades. Instead, teachers and students can collab-

### FIGURE 1

<table>
<thead>
<tr>
<th>Traditional Grade Book</th>
<th>Standards-Based Grade Book</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assignment</td>
<td>Standard</td>
</tr>
<tr>
<td>Mitosis Worksheet</td>
<td>4/5</td>
</tr>
<tr>
<td>Cell Division Lab</td>
<td>20/25</td>
</tr>
<tr>
<td>Quiz</td>
<td>18/20</td>
</tr>
<tr>
<td>Unit 5 Test</td>
<td>92/100</td>
</tr>
</tbody>
</table>

* Note that the standards-based grade book communicates the standards assessed during unit of study rather than emphasizing points earned.
oratively view assessments as an opportunity to learn, rather than merely an exercise in point accumulation (Townsley and Wear 2020). For example, in a high school physics class, we used to have students take an exam over Newton’s Laws. We have more recently had students build mousetrap cars to analyze the mathematical relationship between force, mass, and acceleration of the cars (HS-PS2-1) and make appropriate iterations (Wilcox, Kruse, and Voss 2019). In cases such as this, when we implemented SBG, we found we are much more aware of what students know and can do, and consequently, our teaching has improved. Our better understanding of students and subsequent better instruction have led to increased rigor and learning.

Myth 3: “Grades should be a motivator in my classroom.”

Grades are sometimes used as rewards and punishments in order to motivate students. In this system, if a student turns something in late, points are taken off. If a student participates or does extra credit, points are added. However, if grades are such a great motivator, shouldn’t we eventually see all of the students turning in assignments on time? Shouldn’t all students do the extra credit? While this system of grading can externally motivate some students, it can be deflating for many others.

Instead of using grades as a motivator, grades in an SBG system serve to communicate with students and their parents about the students’ current understanding and skills. As a student learns more, the grade can be changed to reflect that learning. SBG requires a shift in students’ mindset away from obtaining a certain grade and toward learning and applying concepts. The result is that students become more internally motivated (Fink 2015). While “grade chasing” may still occur, the grades in SBG are based upon their understanding of the NGSS. Ultimately, our aim as science teachers is to help students learn at a high level.

Myth 4: “I can use my old ways of grading and just modify it a little bit.”

One possible mindset for adopting alternative assessment and grading systems is to believe that old ways of grading merely need to be modified a little bit. Traditionally, points in the science classroom have not necessarily been equated with grading. SBG does not take into account the number of questions correct or the percentage of points earned when determining levels of learning. While it may seem like a stepping stone to merge points and percentages, this compromise will likely create confusion for parents and students, as well as create a false equivalency in measurement. For example, we once heard that a science teacher kept all the same assignments and just reduced the points down a four-point scale. So, a 40 points assignment was now worth 4 points. If a student got a 32/40, it was converted to a 3.2 on a 4 point scale. Instead of focusing on what students were learning, the teacher only adapted the points aspect of SBG.

When implementing SBG in science, any points assigned to students describe discrete levels of learning (Figure 2). Using a four-level scale, the numbers communicate a student’s proficiency. For example, a student who can effectively evaluate evidence of movements of continental and oceanic crust to explain the ages of rocks (HS-ESS1-5) might receive a 4 out of 4, which corresponds to a deep level of understanding. A 3 may communicate a student’s nearly proficient explanation of plate tectonics, but lacks supporting evidence.

**FIGURE 2**

An example standards-based grading rubric.
Myth 5: “It will take too much time.”
With this grading and assessment shift, some science teachers may be reluctant to overhaul their practices because of the additional workload. When first implementing SBG, it can take time. However, SBG can also reduce meaningless paperwork (Scriffiny 2008). Students are summatively assessed when the teacher feels confident in students’ ability to meaningfully engage with the science and engineering practices and their understanding of core ideas and crosscutting concepts. Therefore, not everything students do requires grading and extensive feedback.

A related concern is the time it takes to make and grade reassessments. While this, too, can take some time, our system puts much of that responsibility on the students. Students need to demonstrate they have done additional work such as reading, studying, or completing meaningful homework before reassessment (Figure 3).

In our experience, we spend more time thinking about what we really want students to learn. We also think about how we can best elicit information about students’ knowledge and skills as well as provide feedback aligned with the standards. To us, this is time well spent.

Myth 6: “SBG does not promote college and career readiness.”
High school science teachers may feel a unique burden to prepare students for college and careers. A possible critique of SBG is that it won’t promote college and career readiness. However, SBG is becoming more commonplace in higher education (Buckmiller et al. 2017). Furthermore, many college professors value students’ understanding of the “why” of science over knowing facts (ACT 2013). Related to this, many people in STEM fields are looking for people who ask effective questions, can critically think, and continue to learn (Wagner 2008). Appendix C of the NGSS (2013) notes, “Research findings indicate that our current system of science education, which places more value on science as a knowledge base than as a way of thinking, is ineffective” (p. 12). Given that SBG often promotes a deeper understanding of science content (Wilcox 2011), it is more likely to promote the types of thinking college professors and employers value.

Myth 7: “Parents and students will not understand the new grade book.”
As with many changes in the science classroom, implementing SBG requires teachers to be deliberate in adopting new practices while being cognizant of the best way to help parents and students understand them. Given helpful connections with situations familiar to them such as athletic teams, communication related to SBG shifts can be simplified. For example, while volleyball coaches provide their athletes with feedback such as “your serving is very good, but your footwork can improve,” science teachers would benefit from explaining to their students that “nearly proficient” on developing a model to illustrate that
Next steps in implementing SBG in the high school science classroom

If you are beginning to implement SBG, consider an in-depth analysis of the assessment in one of your units. The following four steps may be helpful in aligning your assessments, standards, and rubrics:

1. Select an assessment recently completed by science students. Consider the NGSS standard that students are supposed to demonstrate through this assessment.
2. Determine the specific questions aligned to each NGSS standard. This may result in creating new assessment questions, eliminating some redundant or unaligned questions.
3. Use a four-level scale and questions aligned to the standard, and sort the student assessments into four piles, corresponding with generic descriptors of learning such as Beginning, Developing, Nearly Proficient, and Proficient. If possible, ask a colleague to independently sort the student assessments. As needed, come to a consensus on which students should be in each pile based on their demonstrated level of learning for the NGSS.
4. Finally, ask the question for each pile: “What can these students do and do not do in relation to the standard that was assessed?” Create bulleted lists for each pile. These bulleted lists can turn into a rubric for the standard.

The next step for high school science teachers with previous SBG experience may be to explore alternative forms of assessment in their classrooms. For example, teachers who frequently depend upon summative unit tests may consider designing more open-ended tasks that incorporate phenomena such as a mudslide and require students to plan and conduct an investigation of the properties of water and its effects on earth materials and surface processes (HS-ESS2-5). With a grade book focused on learning goals rather than the modality of assessment, science teachers implementing SBG have the freedom to allow students’ voice and choice in their demonstration of learning the NGSS.

When science teachers address these myths and effectively implement SBG in the science classroom, we believe students will have an experience more like the ‘real world,’ participate in a more rigorous course, become more motivated by learning rather than earning, and possess an enhanced understanding of their current levels of learning. Science teachers will benefit from more time thinking about what students should be learning and knowing they are providing a classroom experience aligned with college and career readiness.

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References


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