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# Shifting the Focus from Grades to Learning: Implementing Standards-Based Grading in a Chemical Engineering Material Balances Course

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# Shifting the Focus from Grades to Learning: Implementing Standards-Based Grading in a Chemical Engineering Material Balances Course

**Abstract:**
Traditional grading in engineering education often centers on point-based quizzes and exams. Students receive a numerical score, glance at it, and move on - frequently without engaging with the feedback or reflecting on their mistakes. Instructors, meanwhile, spend countless hours deliberating over partial credit, only to find that their feedback is rarely used. This disconnect between grading and learning prompted a redesign of my sophomore-level material balances course at Penn State, a large R1 university (class size of approximately 120 students).

In Fall 2025, I transitioned to standards-based grading (SBG), guided by *Grading for Growth* by David Clark and Robert Talbert [1]. My goals were to:

1. Encourage deeper learning and mastery of core concepts,
2. Reduce reliance on partial credit as a path to passing,
3. Support students who intuitively grasp content but skip foundational methods, and
4. Reclaim instructional time from grading to focus on teaching.

The course now features standards-based-grading (SBG) assessments and project work evaluated using specifications grading. This paper will describe the implementation process and present outcomes from the first semester - student feedback, TA and instructor reflections, and grade distributions. The findings offer insights into how SBG can reshape student engagement and instructor workload in chemical engineering education.

## Introduction

In Summer 2025, I redesigned *Material Balances in Chemical Engineering*, the first course in our chemical engineering curriculum, transitioning it from a traditional lecture-based structure centered on homework, quizzes, exams, and projects to a standards-based grading (SBG) system. The course is typically taken in the third semester and serves a diverse student population with widely varying levels of prior preparation. The new course design emphasized mastery of clearly articulated learning standards, accompanied by multiple opportunities for reassessment. Final grades were determined by the number and type of standards mastered, along with completion of two major projects.

The goals of this transition were to:

1. Encourage deeper learning and mastery of foundational material balances concepts,
2. Reduce reliance on partial credit as a pathway to passing,

3. Support students who demonstrate intuitive understanding but overlook essential problem-solving methods, and
4. Reclaim instructional time by streamlining grading in order to focus more directly on teaching.

Under SBG, students demonstrate proficiency on individual standards, with reassessment opportunities for any standard not initially mastered. Although I was initially concerned about using this approach in a large class of 120 students, the availability of graduate and undergraduate teaching assistants, maintaining a ratio of approximately 30 students per assistant, made the workload manageable. The redesign was guided by recommendations from Clark and Talbert's *Grading for Growth* [1], along with consultation from an instructional designer at our institution. Both emphasized writing clear, unambiguous standards and "keeping it simple."

While I was apprehensive at the start of the semester, I quickly came to appreciate the clarity and precision that SBG provides. I now have far greater confidence in the abilities of students who earn a C or higher: all have demonstrated proficiency with a defined set of essential material balance tasks. Grading also became more efficient, as the removal of partial credit allowed assessments to be evaluated more quickly and consistently, balancing out the additional time spent on reassessments.

This paper presents my transition journey, including the course design process, implementation decisions, and lessons learned. It also highlights student feedback and reflections on how SBG shaped their understanding, stress levels, and engagement with the material.

**Background**

Historically, university examinations were conducted orally, allowing students to directly demonstrate mastery of the subject matter. As enrollments increased, written examinations and numerical grading systems emerged as a means to manage large classes efficiently [1]. Although numerical grades provide students with a sense of where they stand relative to their peers, this system often obscures which specific skills or concepts they have not yet mastered. Partial credit, intended to reward partial understanding, can also complicate interpretation. In many cases, students accumulate sufficient partial credit to pass a course even when their conceptual grasp remains uncertain. Furthermore, students commonly focus solely on the numerical score of an exam rather than engaging with errors or feedback to improve their understanding. Ironically, despite being introduced as an efficiency measure, traditional grading has become increasingly time-consuming for faculty while offering limited pedagogical value in terms of meaningful, formative feedback.

Alternative grading approaches have emerged to address these shortcomings by shifting the course emphasis from point accumulation to authentic learning. These systems vary in their structure, including ungrading, specifications grading, and standards-based grading (SBG), but share common foundations. They focus on clearly defined learning outcomes, opportunities for resubmission without penalty, and high-quality, actionable feedback. In chemical engineering education, Landherr [2] has explored ungrading through end-of-semester portfolio evaluation and student–instructor conferences, reporting that these methods help reorient students toward learning rather than grades. In later work [3], they found that students benefited from additional structural guidance and light point incentives to support time management and productivity. Across alternative grading models, the central pillars - clear standards, clear assessments, meaningful feedback, and multiple attempts without penalty - are consistent [1].

Specifications grading has been applied in several engineering contexts. Pascal, Vogel, and Wagstrom [4] implemented a binary satisfactory/unsatisfactory system in a chemical engineering laboratory course, where work meeting a $B^-$ level standard was deemed satisfactory. Their implementation did not appear to include reassessments; however, they reported significant reductions in grading time. Mendez [5] used a standards-based specifications system in a hybrid thermodynamics course with streamlined standards assessed through online quizzes. Although the approach was effective at the time, the advances in artificial intelligence make on-line quizzing more challenging.

SBG has gained broader traction in engineering education. Post [6] was among the first to implement SBG in a fluid mechanics course, demonstrating early promise for the method in higher education. Carberry et al. [7] provided a synthesis of best practices for SBG in engineering courses, emphasizing the importance of transparent performance criteria, frequent feedback, and multiple reassessment opportunities, guidelines that align closely with the framework presented by Clark and Talbert [1]. More recently, Banka [8] introduced SBG in a mass transfer/kinetics course, finding that students believed they learned the material more effectively and achieved higher overall grades. Although students initially reported stress related to unfamiliarity with the grading method, they experienced reduced anxiety before assessments due to available reassessment opportunities. The large number of reassessments, however, contributed to a substantial grading load.

Research on student and instructor perceptions further supports the benefits of SBG. Singelmann et al. [9] found that students noted improved clarity, reduced performance pressure, and greater focus on mastery rather than point accumulation. Although students did not explicitly highlight the transparency of learning objectives in focus group discussions, their repeated references to specific standards indicated strong internalization of the course outcomes. Instructors in the same study affirmed that SBG sharpened the alignment between course objectives and assessments. These findings parallel classroom observations in which students readily identify both the standards they have mastered and those requiring further work.

A growing body of evidence suggests that alternative grading approaches may also reduce student stress and performance anxiety. Lewis [10] found that SBG reduced test anxiety and eliminated gender differences typically observed in exam anxiety within traditionally graded courses. The clarity of expectations and the opportunity to demonstrate mastery over time also align with growth-mindset principles, supporting persistence, reducing fear of failure, and encouraging students to view learning as iterative rather than fixed.

Taken together, research across engineering education indicates that alternative grading systems, whether ungrading, specifications grading, or standards-based grading, offer promising pathways to improve transparency, support student learning, reduce anxiety, and foster a growth-oriented classroom culture. These approaches, while varied in implementation, share a commitment to clearly articulated learning outcomes, meaningful feedback, and opportunities for students to improve through revision and reassessment.

## Methods

The course transitioned to standards-based grading (SBG) was *Material Balances in Chemical Engineering*, a three-credit, sophomore-level course at a large public Division I institution. The class met for three 50-minute sessions per week over a 15-week semester, followed by a final exam week. Enrollment in Fall 2025 (SBG offering) was 120 students, with 104 students completing the course. This level of attrition was comparable to the Fall 2024 offering, which used a traditional points-based grading system. In the Fall 2025 semester, approximately five students withdrew at the late-drop deadline after being advised that they were unlikely to pass because they had not yet mastered the foundational standard of performing single-unit, steady-state material balances. Additional early withdrawals occurred for unknown reasons. Two students who were advised to drop chose to remain enrolled and ultimately earned a failing grade.

### *Course Structure and Standards*

The SBG implementation included nine **core standards**, representing essential competencies that all students were required to master to earn a grade of C or higher. Five additional **extension standards** covered advanced or supplementary material, enabling students to earn grades above a C when mastered. Each standard was assessed as either proficient or developing. Students had up to three attempts to demonstrate proficiency for core standards and two attempts for extension standards. Proficiency was determined based on demonstrated conceptual understanding and successful completion of the task articulated in the standard; minor algebraic mistakes did not preclude proficiency when conceptual mastery was evident. The complete list of standards is provided in *Appendix A.*

### *Comparison of Assessment Structures*

The Fall 2024 traditional offering included five in-class quizzes (with the lowest dropped), one out-of-class midterm exam, a final exam, and a multi-deliverable final project. When converting to SBG, the most significant challenge was creating sufficient opportunities for assessment and reassessment. The Fall 2025 SBG course used six in-class assessment periods and three out-of-class assessment sessions, two of which offered both new assessments and reassessments, with the third dedicated solely to reassessment. A final exam period was also used exclusively for reassessment of missed standards. A comparison of the assessment times is shown in Table 1. Overall assessment time was comparable across the two course offerings, though SBG required two additional out-of-class sessions devoted to reassessment. Future offerings will include a scheduled recitation session to create more consistent reassessment opportunities.

*Table 1 Comparison of Assessment Methods in 2 Different Offerings of Material Balances*

| | Traditional Fall 2024 | SBG Fall 2025 |
|---|---|---|
| In-class assessments | 5 quizzes (drop one) | 6 (not all required for a C) |
| Out of class assessment (2-3 hours) | 1 midterm | 3 sessions (one dedicated to re-assessment only) |
| final | Traditional 2 hour final | Reassessment only; no new standards |
| projects | 1 final project with multiple deliverables | 1 introductory project; 1 multi-deliverable final project (partial completion required for grade of C) |

*Development of standards and grading rubric*

In designing the SBG course, clear articulation of learning objectives was the first priority. Following recommendations [1,7], each standard was written as an explicit “I can…” statement to improve transparency for students and align directly with course objectives. After outlining all potential standards, the instructor identified the essential competencies required for students to advance in the chemical engineering curriculum. These became the nine core standards. The remaining standards were designated as extension standards, supporting higher grades.

Because this course is a C-required gateway course, the core standards were selected to reflect the minimum competencies necessary for students to succeed in subsequent chemical engineering courses. A complete list of the core standards used in this material balances course is provided in *Appendix A*. The remaining standards were designated as extension standards, which represented either (1) more advanced applications of the core standards (for example, combining recycle and reaction systems) or (2) additional content beyond the minimum requirements. Lack of proficiency on these extension standards was not expected to hinder students’ progress in the curriculum but instead served as a pathway to higher course grades.

Additional course requirements, including statistics content and career-development activities, were incorporated into the grading rubric as separate standards. These were assessed through homework assignments or mini-projects rather than in-class quizzes, with reassessment opportunities available until proficiency was demonstrated. Two projects were included in the course:

1. **Project 1**, designed to introduce students to professional deliverables such as constructing formula-based Excel sheets and writing technical memos.
2. **Project 2**, a comprehensive material balance design project involving recycle and reaction and using Excel to run different scenarios.

For this offering, the projects were placed in their own category within the rubric. Each deliverable was graded using specifications; proficiency required meeting all listed criteria, and reassessments were allowed. Table 2 presents the full grading rubric used in the Fall 2025 SBG course. To earn a particular course grade, students were required to complete all boxes at or below that grade level.

*Table 2 Grading rubric used in SBG Fall 2025 offering of material balance course*

| Grade check sheet | **D** | **C** | **C+** | **B-** | **B** | **B+** | **A-** | **A** |
|---|---|---|---|---|---|---|---|---|
| **Core** learning standards completed out of 9 | ☐ ☐ ☐<br>☐ ☐ ☐<br>☐ ☐ | ☐ | | | | | | |
| **Extension** standards | | | ☐ | | ☐ | | ☐ | ☐ |
| **Statistics** Standards | None required | ☐ | | ☐ | | | | |
| **Career Development** grade | 60%+ | 70%+ | 75%+ | 75%+ | 75%+ | 80%+ | 80%+ | 80%+ |
| **Homework** grade | 60%+ | 65%+ | 70% | 70% | 70% | 75%+ | 75%+ | 75%+ |
| **Project 1** completed to satisfactory level | None required | ☐ | | | | | | |
| **Project 2** number of deliverables (D) completed and level S-satisfactory<br>E-excellent | None required | D1 S+ | | D2 S+ | | D2 E+ | D3 S | |
| Participation adjustment | Less than 75% move down one grade step, 90% or greater move up one grade step | | | | | | | |

*Reassessment opportunities and other grading components*

Reassessment opportunities were available for core standards (up to three attempts), extension standards (up to two attempts), and all statistics standards and project deliverables (unlimited attempts). The career-development module was graded solely on completion, reflecting its reflective and self-development focus and is discussed in detail in a separate paper [11]. Homework assignments allowed opportunities to earn back points; however, the minimum homework requirement for a C was lowered mid-semester after noting that several students demonstrated full mastery of standards and projects despite low homework completion.

Participation included completion of in-class activities, pre-class readings, and online pre-class quizzes on reading material. These components were graded for completion only. Students earning at least 90% participation were eligible for a one-step grade bump (e.g., B to B+), applicable only for students earning a C or higher.

*Student survey*

During the final week of the Fall 2025 semester, students completed an anonymous survey designed to gather feedback on their experiences with SBG in the course. The entire class was given a few bonus points on their homework grade for participating in the survey, whether they participated or not. Completion rate was 84%.

**Results and discussion**

A primary concern when transitioning to standards-based grading (SBG) was the overall grading workload. Contrary to initial expectations, grading became more efficient. Assessments were easier and faster to evaluate because each problem targeted a single standard and was scored simply as *proficient* or *developing*. This allowed the teaching team to provide highly specific feedback and return graded assessments rapidly, often within one day for all 120 submissions. Compared to traditional quizzes and exams, evaluating SBG assessments proved both more manageable and more pedagogically meaningful.

The projects, however, generated a substantial grading load. The second project contained four deliverables, and in retrospect, equivalent learning outcomes could have been achieved with two or three. In future iterations, the first deliverable will likely become a required component for all students, while additional deliverables may be integrated into the extension standards category to offer students greater flexibility in how they demonstrate higher-level mastery. A token-based system may also be implemented to limit excessive resubmissions, which contributed to grading load in this initial offering. Nonetheless, the experience suggests that thoughtful project design can prevent grading burdens from outweighing the benefits of SBG.

Although learning objectives had always informed exam design in the traditional course, exam questions were not explicitly linked to a single objective. As a result, it was often difficult to determine exactly where a student was struggling. To address this, traditional problems were broken into multiple sub-questions, each assigned a point value, which inadvertently scaffolded the problem for students. In contrast, under SBG each assessment clearly stated the standard being evaluated and provided a single, un-scaffolded problem aligned with that standard. This approach required students to engage fully with the problem-solving process, and raised the level of mastery required compared to partial-credit systems. It also provided precise information about which standards each student had mastered.

To support conceptual understanding, all assessments required students to write out equations clearly, show problem-solving steps, and include a diagram. Missing equations resulted in a "developing" mark. This approach encouraged students to adopt systematic problem-solving habits rather than mental arithmetic shortcuts. For example, one student initially resisted writing full equations, relying on mental reasoning to solve problems. Because proficiency required a complete written solution, the student was required to reassess until the full method was demonstrated. This reinforced the importance of methodical engineering practice, particularly as problems grow more complex later in the curriculum.

Another observed advantage of SBG was greater insight into student learning. Because each assignment was directly tied to a specific standard, the learning mastery gradebook available in Canvas, our learning management system, provided clear visibility into which concepts students were struggling with. Students could not bypass foundational ideas: they were required to master the nine core standards before attempting the extension standards. This ensured full competency in essential topics. For example, one extension standard combined recycle and reaction balances in a single steady-state system, traditionally a challenging exam problem. Surprisingly, many students mastered this extension on their first attempt. This outcome likely reflects the benefit of first mastering the component skills individually, handling recycle systems and reaction systems separately, before combining them.

Students acclimated to the grading system more quickly than expected. Figure 1 shows that the majority understood the structure after the first assessment, administered during the third week of the course. Some reassurance was needed early on, particularly regarding the availability of reassessments, but students generally expressed confidence that they would be able to master each

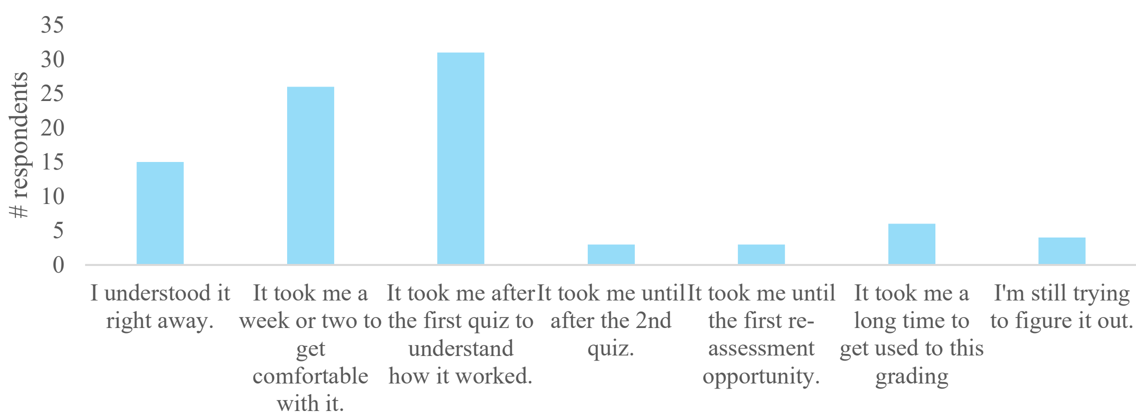
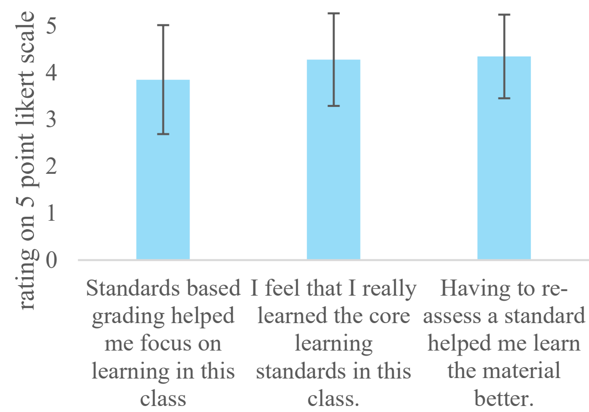



*Figure 1. Students were asked how long it took them to get used to SBG.  88 students responded*

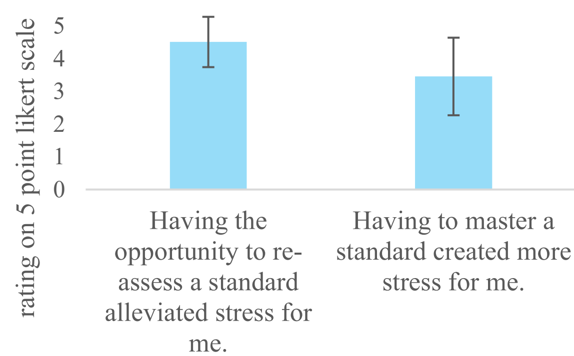
standard with effort. As shown in Figure 2, students reported that SBG helped them focus more directly on learning and that they learned the core standards of the course more deeply. While these perceptions are encouraging, longitudinal data from subsequent courses will be needed to determine whether students' self-reported learning gains align with their future academic performance.




5= strongly agree, 3= neutral, 1= strongly disagree

*Figure 2. Student self evaluation of learning with SBG on a 5 point likert scale showed that they did believe it helped them focus on learning and learn the core learning standards.*

The distribution of core standards mastered on the first attempt (across the first five standards) resembled a traditional bell-shaped exam distribution. Out of 118 students, 50 mastered fewer than three out of five standards on their first attempt, which would typically correspond to C-level performance or lower in a traditional course. However, by the end of the semester, 100 students earned a C or higher and demonstrated proficiency in all nine core standards. In a traditional grading system, students who struggled early often abandoned those topics; but in SBG, repeated opportunities motivated them to persist and ultimately achieve mastery.




5= strongly agree, 3= neutral, 1= strongly disagree

*Figure 3. Stress associated with SGB as reported by students on a 5 point likert scale.*

Student stress was another point of interest. Figure 3 shows that students strongly agreed that reassessment opportunities reduced stress. When asked whether the requirement to master certain standards increased stress, students responded near the neutral midpoint. This suggests that while required standards introduced some pressure, the ability to reassess significantly mitigated anxiety.

Some students required a fourth attempt on a core standard. After the seventh standard had been assessed three times, several students were close to proficiency, but not yet there. These students were invited for individual meetings to identify misconceptions, and they were allowed a fourth attempt. Those who were near proficiency succeeded on this attempt, while students who were further from mastery did not. This experience highlighted the value of instructor intervention and suggested that occasional fourth attempts, which should be implemented transparently and with clear guidelines, may support student success. It also illustrated how SBG enables instructors to identify learning gaps with precision and intervene effectively.


*Figure 4. Grade distribution comparison between traditionally graded course and SBG course.*

Finally, overall course grades were higher in the SBG offering compared to the traditional version, as shown in Figure 4. Several factors likely contributed to this outcome. First, the threshold for earning an A was more attainable than initially intended. The initial design required students to complete all project deliverables and master four of the five extension standards. However, because the participation policy allowed a one-step grade increase, an A became achievable with mastery of only three extension standards. Interesingly, despite only three extension standards being required, 7% of students chose to assess and master all five, and 25% mastered four of the five. Even with these thresholds, the projects remained demanding and were a considerable source of stress. In future iterations, integrating certain project deliverables into the extension standards may provide students with greater flexibility while reducing grading load and balancing expectations.

A second factor that may have contributed to higher grades is the motivational structure of SBG. By the late-drop deadline, 64% of students had mastered all nine core standards, securing at least a C in the course; 15 % had mastered eight of nine; and 16% had mastered seven of nine. Those that had not mastered at least the first 7 core standards were advised to drop the class as those standards were not to be re-assessed again. Students felt confident they could master the one or two remaining core standards and recognized that their course grade could only improve through continued effort. The grade distribution suggests that students capitalized on this opportunity: relatively few C or C+ grades were earned. Analysis of standard mastery before and after the later-drop deadline further supports this observation. Among the entire cohort, only five students did not master any additional standards after the deadline. Of these five, two had already completed all three extension standards required for an A; two had mastered two extension standards; one had mastered a single extension standard; and only one had completed none. All other students continued working to master additional standards.

At the same time, the SBG structure may pose challenges for some students. For example, one student who was making good progress, and had already mastered all core standards and secured a C by the late-drop deadline, ultimately withdrew because they felt anxious about not knowing whether they were on track to earn an A. The student did not meet with the instructor prior to dropping the course. This anecdote highlights how strongly some students value grade certainty, even when they are successfully mastering content, and suggests the need for clear communication about progress and grading trajectories throughout the semester.

A final lesson learned concerns naming of the assessments. For lack of imagination, they were called quizzes and exams, following university practice when scheduling them. Even though the assessments were short and targeted, even when offered during the longer “exam periods”, students reported increased anxiety when they were labeled as “exams.” Renaming assessments as *proficiency checks* or *mastery checks* instead of quizzes and exams may help reduce stress and better align with the philosophy of SBG.

**Conclusion**

The transition to standards-based grading (SBG) in a large-enrollment material balances course met the goals initially established and suggests that alternative grading frameworks can enhance student learning, clarity, and persistence while remaining manageable for instructors when implemented thoughtfully. The clear articulation of core and extension standards, paired with frequent and structured opportunities for reassessment, allowed students to focus on mastering essential competencies rather than accumulating points through partial credit. This shift aligns closely with the pedagogical goals of engineering education by emphasizing conceptual understanding, methodical problem-solving, and iterative improvement.

Despite initial concerns about grading workload, SBG assessments proved far more efficient to evaluate than traditional quizzes and exams. Because each problem targeted a single standard and was scored simply as *proficient* or *developing*, feedback could be provided both quickly and with greater specificity. Although project grading remained time-intensive, this experience highlighted the importance of designing project deliverables with simplicity and intentionality. Future refinements, including integrating some project components into extension standards and possibly implementing a token-based resubmission system, may reduce grading load and increase student agency.

The results further showed that SBG provided high-resolution insight into student understanding. Because each assessment was mapped directly to a learning standard, instructors could identify misconceptions quickly and intervene effectively. Students who initially struggled with core concepts were able to achieve proficiency through repeated practice and individualized support, even in a large class of 120 students. By the end of the semester, nearly all students mastered all nine core standards.

Student survey responses indicated that SBG helped them focus on learning and reduced stress due to the availability of reassessments. Although some anxiety persisted around required standards and longer assessment periods, students reported high overall clarity and confidence with the grading system after the first assessment cycle. The evidence suggests that naming conventions and framing of assessments (e.g., “proficiency checks” rather than “exams”) can further mitigate stress.

Finally, grade distributions improved in the SBG offering compared to a traditionally graded iteration of the course. While some of this increase may be attributable to the participation boost build into the structure, the results also reflect students’ ability to persist and demonstrate true mastery over time. These outcomes are consistent with prior research showing that alternative grading approaches can reduce anxiety, support mastery-oriented learning, and improve student performance [1, 9, 10].

In sum, the implementation of SBG in this course demonstrates strong potential for improving transparency, equity, and depth of learning in foundational chemical engineering courses. Continued refinement, including streamlined project structures, intentional reassessment policies, and reduced emphasis on traditional exam terminology, will further enhance the effectiveness and sustainability of SBG. Continued evaluation of this student cohort as they progress through the curriculum will provide additional insight into the long-term impact of SBG in a foundational course on learning outcomes.

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## Appendix A

List of Standards for SBG material balances, notes for future adjustments are included in parentheses

C indicates a Core Standard

E indicates extension Standard

| | |
|---|---|
| | **Module 1** |
| C1 | CORE I can convert between units and combination units as needed, including English units and parts per (m/b)illion. (note: would add more examples in future) |
| C2 | CORE I can differentiate between concentration and density and use them correctly. |
| C3 | CORE I can determine the individual component compositions of a stream containing a solid precipitate in solution (filter cake/precipitate). |
| | **Statistics (in class or homework)** |
| S1 | I can apply standard deviation to determine out of bounds data/process output. (note: would add – using Excel function and using equations) |
| S2 | I can do linear regression of data to find linear model parameters. (note: would add – using Excel function and using least square regression equations with solver or similar) |
| | **Module 2** |
| C4 | CORE I can set up the problem: draw diagram (draw a diagram of the process description), label streams either on diagram or in table including units and variable names, id unknowns, write assumptions and assess reasonableness, and pick a basis. |
| C5 | CORE I can solve a non-steady state single unit material balance problem (total) by writing a total material balance with one time dependent variable and show how it turns into a steady state problem. |
| C6 | CORE I can solve a steady state single unit mass balance problem by writing total and component material balances. |
| | **Module 3** |
| C7 | CORE I can solve a multi-unit material balance problem without reaction with recycle/purge/split. |
| | **Module 4** |
| C8 | CORE I can define and use fractional conversion, extent of reaction, yield, selectivity, and % excess reactant. |
| C9 | CORE I can solve a material balance with reaction and choose an appropriate method of solving using either extent of reaction, molecular balances, or atomic balances. (note: I would make this atomic balances specific) |
| E1 | I can determine the extent of reaction of an equilibrium reaction. |
| E2 | I can solve a combustion material balance using excess oxygen/air. |
| | **Module 5** |
| E3 | I can solve a material balance problem with reaction and recycle and purge. |
| | **Module 6** |
| E4 | I can solve a vapor liquid equilibrium problem using Raoult's Law and use it to solve a multi-phase material balance problem. |
| | **Module 7** |
| E5 | I can solve a non-steady state multicomponent material balance. |