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Ungrading in organic chemistry: students assessing themselves and reflecting on their learning

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The focus on grades has diminished the focus on learning. One strategy that aims to return students' attention to what they are actually learning (and not just earning) is ungrading. Ungrading is thought of as any strategy in which instructors do not assign a number or letter grade to students' assignments and assessments. Instead, faculty may (1) provide thorough feedback and engage in dialogue with students about their work, and perhaps, (2) allow students to assign their own grade. Whichever style of ungrading they choose, the scholars that have been forging the path for ungrading come from a variety of fields and perspectives, including STEM instructors in more recent years. The focus on incorporating ungrading practices into the organic chemistry curriculum provided here is adapted from a variety of practitioners, and especially the foundational work of chemistry professor Clarissa Sorensen-Unruh. In addition to discussing the current ungrading practices in various fields, we will use this perspective article to share our own experience with and lessons learned from beginning to incorporate ungrading in the undergraduate organic chemistry curriculum, both as it relates to the implementation of the practice and our own perceptions of the student experience and learning outcomes. Ultimately, the goal is to allow students to see the significance of the process of learning and to engage in some metacognitive work that they can apply to different assignments, whether in our class or not. If we want students to focus on learning, perhaps they should do the grading themselves.

KEYWORDS

grading, ungrading, organic chemistry, chemistry education research, metacognition

1 Introduction

Attention toward assessment has been increasing in recent years for multiple reasons ([Digital Science, 2018](#) and [Supplementary Figure 1](#)). As demands on faculty time continue to grow, there are attempts to decrease instructor time and energy spent grading. It is also important to help students learn that their grade in a particular class should not be considered a reflection of how much time they spent reading, studying, or working practice problems. This common misconception, that time spent is automatically equivalent to knowledge obtained, and thus grade earned, is one that many instructors report as an issue

for their students (Kemmerer, 2014; Carver et al., 2017). Students spend time outside of class on their coursework, but it is the quality and focus of that study time, like the use of self-testing, that is typically positively associated with grade outcomes (Hartwig and Dunlosky, 2012; Fergus, 2022). Students may understand that higher quality studying leads to better grade outcomes, but they don't always know how to implement it (Tomes et al., 2011; Fergus et al., 2021; Carpenter et al., 2024). To help *students* better assess their own learning, we must take a more meaningful approach to how *instructors* assess their learning.

Several reviews offer historical highlights of traditional assignments of alphanumeric grades. Cureton's article from 1971 indicates that "percentage grading," established as early as the mid-1800s, occurs when instructors determine what proportion of the maximum grade (usually out of 100) a student should earn on a given essay or examination (Cureton, 1971). By the beginning of the 20th century, due in part to increased student populations and a need to communicate student abilities between institutions, grading on a letter scale gained popularity as a universal standard (Schinske and Tanner, 2014). Furthermore, using a normal distribution curve for assigning letter grades was accepted as a meaningful measure of student abilities, while minimizing subjectivity of individual instructor's marks (Schinske and Tanner, 2014).

Though he wasn't the only skeptic of the time, in 1968, Bloom questioned the validity and "sacredness" of the normal distribution curve for grades and encouraged instructors to use strategies that improved mastery of learning (Bloom, 1968). Referencing Carroll's *A Model of School Learning* (Carroll, 1963), Bloom says "if the students are normally distributed with respect to aptitude, but the kind and quality of instruction and the amount of time available for learning are made appropriate to the characteristics and needs of *each* student, the majority of students may be expected to achieve mastery of the subject" (Bloom, 1968). As instructors have attempted to modify their teaching methods to improve student learning, they have also adjusted their expectations about the normal distribution of the number of As and Fs granted. This change in philosophy has led many to question what grades really mean - or at least, what they're supposed to mean - and alter their approaches to assigning grades.

1.1 Support for ungrading

Even well-known proponents of the strategy tend to be fairly vague when defining ungrading, perhaps trying not to exclude practitioners willing to disrupt conventional grading techniques. Jesse Stommel says it means "raising an eyebrow at grades as a systemic practice, distinct from simply "not grading"" (Stommel, 2023). Since the 2020 release of her edited book *Ungrading: Why Rating Students Undermines Learning (and What to Do Instead)*, Susan D. Blum has taken the perspective that the term should be an umbrella term, describing a variety of approaches (Blum and Kohn, 2020). Katharine E. Johanesen takes it further, saying ungrading describes "a variety of practices that decenter grading in a class. [It] often involves eliminating or reducing numeric scoring in favor of descriptive feedback and/or reflection" (Johanesen et al., 2023). Ungrading can involve allowing students to assign their own grade

at the end of a course, giving students tools to grade their own individual assignments, or anything else in between and beyond.

Kohn compiles several issues with assigning traditional grades, ranging from adverse effects on student learning and motivation, to the negative effect of grades on the relationship between student and teacher (Kohn, 1999). Compared with traditional grading, ungrading provides some hope for instructors that are looking to improve students' intrinsic motivation. Researchers like Butler, Green, and Grant have observed that using grades as a source of external motivation might push students to work for a better grade, not necessarily to learn the material, or engage in classroom assignments and discussions (Butler, 1988; Grant and Green, 2013). Ungrading can be used to help students focus on what they need to learn - or what they *have* learned - as opposed to assigning an alphanumeric grade.

Importantly, ungrading has the potential to minimize or eliminate inequity in college classrooms, though the true benefit seems yet undetermined. In *Undoing the Grade: Why We Grade and How to Stop*, Jesse Stommel argues that the current approach to grading is already harmful, and that any new approaches, such as ungrading, should be designed with flexibility, care, and structure (Stommel, 2023). Supiano's 2022 *Chronicle* article discusses math professor Robert Talbert's question of whether ungrading makes the equity gap worse (Supiano, 2022). Notably, removing grade "guideposts" may make it harder for marginalized students to know where they stand. But students who are already at an advantage, by having college-educated parents for example, are having to learn a new system just like everyone else, potentially leveling the playing field. In their recent book *Grading for Growth: A Guide to Alternative Grading Practices That Promote Authentic Learning and Student Engagement in Higher Education*, Clark and Talbert discuss various benefits of alternative grading, including ungrading, like providing clear standards, allowing for reassessment without penalty, and "focusing on eventual understanding", which is expected to minimize biased grading (Clark, 2023). With appropriate intention and care, instructors may find ways to enhance equity in their classes with the help of ungrading.

1.2 Examples of ungrading strategies in STEM

We were inspired by STEM educators who have recently begun exploring the ungrading landscape in their courses. Riesbeck and Cangialosi teach computer science and biology, respectively, yet their approaches to ungrading are quite similar - and they've been in practice for over 20 years. Essentially, they both provide feedback, without assigning grades, to student assignments and allow the student to resubmit their work with revisions and improvements (Riesbeck, 2017; Cangialosi, 2020). Cangialosi goes a step further by asking students to complete self-assessments to describe their activities and how successful they think they've been. She reports that this is a rather illuminating experience, as students are not typically equipped to accurately translate their efforts into an appropriate grade. For instance, she mentions that a student who had not yet started on a project gave themselves a "C" grade, instead of a failing grade (Cangialosi, 2020). This disconnect allows

her to have conversations with her students about what grades actually mean, while still giving them the agency to improve based on feedback she provides.

More recent STEM ungraders have leaned into the element of student self-reflection and assessment. Katharine Johannesen's excellent 2023 report describes a number of ungrading iterations in her geosciences courses that she has made over the years, in conversation with other examples in the field (Johanesen et al., 2023). Because of the clear emphasis on self-reflection and structures provided for students to assess themselves, she reports that students felt less anxious and more supported by the end of the semester.

In chemistry, two prominent ungrading figures are Courtney Sobers and Clarissa Sorensen-Unruh (Jarvis, 2020). Sobers describes her experience with ungrading in a general chemistry II laboratory class: she gives feedback, allows for student revision and self-assessment, and confirms that their revisions are correct (Rutgers School of Arts & Science-Newark, 2021). Sorensen-Unruh has incorporated ungrading to varying degrees in several of her general and organic chemistry classes, including requiring students to grade their own mid-term exams (Jarvis, 2020).

Sorensen-Unruh's motivation for ungrading resonated with us as well, particularly her remarks in her online blog and book chapter in Blum's *Ungrading*: "I came to believe grading undermines learning daily by focusing student interest on achievement and not on learning" (Sorensen-Unruh, 2020). We encourage interested parties to read the full book chapter, but to briefly summarize her approach, students took their mid-term exams as normal, Sorensen-Unruh would write feedback on each exam and keep track of scores assigned for specific problems in her own private spreadsheet. She then returned the exams to students, and they would grade themselves. Sorensen-Unruh accepted the student's grade as long as it was within a standard deviation of her own assessment. Further, the more accurate the student was in their self-assessment, the more likely she was to assign extra credit, incentivizing accurate corrections and grade assignment. Sorensen-Unruh's experience reflects a cooperative and amicable relationship between faculty and students as it relates to their grade assignment. She highlights the importance of trust in the relationship, but also accountability and structure. Even her students recognize the value of ungrading, with one saying, "I feel like ungrading focuses on the higher level concerns and therefore encourages a deeper understanding of the material, despite some potential issue with lower level ideas" (Sorensen-Unruh, 2020). Getting students to understand the significance of higher order learning, as opposed to nitpicky point determination, is exactly the sort of experience we were hoping to replicate in our own work.

2 Our experience

2.1 Background

Like many others, we were interested in making some pedagogical changes in aftermath of the Covid-19 pandemic, which prompted our foray into the relatively unexplored ungrading territory. For the Fall 2020 semester, our institution offered one or two condensed courses at a time to help mitigate the spread

and impact of Covid-19 on our campus. To facilitate a productive learning environment given much longer lecture periods of 3 h, we flipped all organic chemistry courses in both the first and second semester. Students could learn the material through recorded lecture videos before class, and we spent lecture time together solving relevant practice problems. After this first academic year of teaching the courses this way, we wanted to include more avenues for students to take control of their own learning, rather than relying on our assigned grades. We also sought to encourage students to reflect on (or at least *acknowledge*) the feedback we provided them, which often went unread. In this new era of intensive active learning in the course, it was important that students fully realized their power in both learning and assessing their own learning - ungrading provided a helpful avenue for this metacognitive work (Carpenter et al., 2024).

2.2 First iteration

Like many others report regarding their first experience with ungrading, we were apprehensive to get started. Inspired by Sorensen-Unruh's incorporation of the strategy in her own chemistry classes, particularly her desire to "divorce grades from feedback" (Jarvis, 2020), we decided to start small with the four in-class quizzes we provide over the course of a semester. The model that we follow for quizzes is adapted from Sorensen-Unruh's approach with exams (Sorensen-Unruh, 2020). In our initial iteration of ungrading, students took a 15-min quiz in class, which was immediately collected by their instructor. After class, we scanned the original copies of the completed quizzes and returned them to students the same day, as indicated in the instructions (Figure 1A). Using an available rubric on our learning management system, students graded themselves over the course of several days, and turned in their completed ungraded quiz at the next class meeting. We assessed their ungraded quizzes, including confirming a numeric grade, and returned them the following class meeting. Importantly, the provided rubric did not have correct answers. Instead, it included how many (if any) partial points to assign based on the correct answer(s) given by students. The intention was that students would review their notes, the textbook, and/or visit office hours to confirm their answers or gain insight into how to solve the problems. This approach was fairly manageable for us with class sizes of approximately 20–35 students.

2.3 Revisions

Reflecting after the first semester of offering these ungraded quizzes, we identified a few modifications that would provide a bit more structure to students as they did this reflective work, many of them for the very first time (Figure 1B). First, we made the rubrics more detailed (Supplementary Figure 2). In addition to providing the points students should assign themselves for various parts of the answers, we directed students to the appropriate sections of the required textbook and/or included helpful context for solving the problems. We had found that students needed more instruction to determine whether or not they even answered the questions correctly.

A	<p>CH221 FA21 Organic Chemistry I Dr. Bonner, Dr. Ferguson, and Dr. Grove Quiz 1 September 16, 2021</p> <p>INSTRUCTIONS: This quiz will be scanned and saved after class so that we have a copy of the original. Please pick it up from the ledge outside of CMLS 139 this afternoon. After picking it up, grade yourself according to the Quiz 1 Rubric on Moodle and turn it in to your professor at the beginning of your next class (Tuesday September 21, 2021).</p>	<p>Name _____ First initial and last name only</p> <p>Pledged _____</p>
B	<p>CH221 FA23 Organic Chemistry I Dr. Bonner, Dr. Ferguson, and Dr. Grove Quiz 1 September 14, 2023</p> <p>INSTRUCTIONS: You will have a choice for grading. Read the descriptions below and circle one option before turning in your completed quiz.</p> <p style="text-align: center;">Please circle one: Option 1 or Option 2</p> <p>Option 1: <i>Graded by your professor.</i> When you turn this quiz in, that's all that's required of you. You will receive your graded quiz during the next class period. This option does not have an opportunity for additional bonus points.</p> <p>Option 2: <i>Ungraded by you, with reflections and corrections for EACH question, even the ones you answered correctly.</i> Please pick it up from the ledge outside of CMLS 139 this afternoon. After picking it up, grade yourself according to the Quiz 1 Rubric on Moodle. <i>Additionally, you need to provide corrections and a reflection (using words), explaining the process for solving the problem and making improvements for any missed questions. This reflection may be typed or handwritten.</i> Turn the ungraded quiz and your reflection in to your professor at the beginning of your next class (Tuesday September 19, 2023).</p> <p style="text-align: center;">A well-graded quiz with thorough reflection will receive up to two additional bonus points. A reflection should include your problem-solving process, even for questions you answered correctly.</p>	<p>Name _____ First initial and last name only</p> <p>Pledged _____</p>

FIGURE 1
Organic Chemistry I ungraded quiz instructions for (A) Fall 2021 and (B) Fall 2023.

Second, students were allowed to receive up to two additional bonus points for providing appropriate corrections and reflections - even if they answered all questions correctly. Recognizing mistakes and correcting them is an obviously helpful tool that we have encouraged for years, but now those corrections are incentivized in a way that they weren't before. The reflections (recommended by colleague Sarah K. Zingales) reinforce the notion that having students see their mistakes, make corrections, and meaningfully reflect on their problem-solving process, *and how that process might need to change*, is so valuable for the metacognitive work we need students to engage in.

Lastly, we realized that we needed to give students more choice. Most, if not all, students enrolled in either semester of Organic Chemistry are also taking at least one or two other science courses with associated 3-h labs. Many of our best students are also teaching assistants, tutors, resident advisors, and/or working in the on-campus, student-run emergency response team. Although we recognize the impact of making corrections and self-reflection on their own learning, sometimes time constraints limit a student's ability to meaningfully engage in this work. Students are allowed to opt-out of ungrading for each quiz if they so choose, and are thus ineligible for the two bonus points. Most

students still choose to ungrade themselves, anywhere from 80 to 100% of the time.

These three changes were implemented in the very next semester, Spring 2022, during the Organic Chemistry 2 lecture courses, and we still use them in Spring 2024.

3 Discussion and future directions

3.1 Impact on faculty time

We feel the need to be very clear about one thing - this version of ungrading does not reduce the grading burden on faculty. In fact, in our experience, it takes *longer* to evaluate students' ungraded efforts and reflections than it would to simply grade the quizzes. In order to ensure the students actually graded themselves correctly, we essentially grade them twice at once - both the original answers and the students' assessment of their answers. Reviewing student reflections is also time-intensive, but we find it to be a worthy component to help achieve our metacognitive goals.

Ultimately, if your goal is to reduce the amount of time you spend grading, use a different ungrading approach. If your goal is to

help students meaningfully reflect on their own learning, this could be a valuable strategy for you to try.

3.2 Impact on student outcomes

From our viewpoint, most students tolerate the ungrading strategy and are willing to participate in the process of grading themselves. The most well-prepared students do well when making quiz corrections and reflecting on their thought processes, and those insights seem to last as they prepare for exams. We suspect that a correlation exists between student accuracy in ungrading quizzes and exam performance, but we do not yet have the data to verify this suspicion. As such, we have concerns that the students who were already going to perform well in the class are the ones that typically perform better on their ungraded quizzes, as well as their reflections. Incentivizing accurate corrections and reflections with bonus points does seem to encourage the average and lower performing students, but it is clear that the primary beneficiaries are the top students.

A challenge we have faced is that some students will over-assess their performance on assignments or the course, giving themselves a higher grade than they actually earned, despite our inclusion of the detailed rubric with instructions on how to find correct answers. In our experience, the discrepancy is less likely because of an attempt to “game the system”, and more likely a result of not attributing the necessary time and effort toward accurately assessing themselves. It is unclear whether they do not recognize their mistakes, do not refer back to the required resources, or simply underestimate the amount of time and effort it takes to critically reflect on their work.

We believe that this process of ungrading and self-reflection helps students learn how to learn, a valuable skill that can be applied throughout their college and professional careers.

3.3 Future directions

As ungrading becomes increasingly prominent in the academic and popular literature, we will continue to look to our STEM peers for insights to refine the process in a way that works for us and our students. As we seek to develop and identify improvements to our ungrading process, it is critical that we consider the important balance between giving students ownership of their grade, and holding them accountable for learning the content. Organic chemistry is a gateway course into upper-level chemistry courses, as well as many health-related professional graduate programs. Making sure that students use ungraded assignments as opportunities to reflect on their learning, and to think about their thinking, is critical to their success in the future.

In the future, we would like to investigate the longitudinal outcomes of applying this assessment structure. As mentioned, we expect a correlation between ungrading accuracy and exam performance. Perhaps other correlations may exist, such as grade outcomes in the second semester of organic chemistry or other upper-level chemistry courses. It will be important for chemistry education researchers to compare course outcomes for students who reflect on their answers, both correct and incorrect ones, with

those who just make corrections on original answers. If differences are present, we could evaluate whether the differences can be attributed to student effort, faculty expectations, prior chemistry preparation, or something else. Regardless of the findings, it is important that we learn more about ungrading, and that we don't give up the practice.

Data availability statement

The original contributions presented in this study are included in this article/[Supplementary material](#), further inquiries can be directed to the corresponding author.

Author contributions

JF: Writing – review and editing, Writing – original draft. LB: Writing – review and editing, Writing – original draft.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/feduc.2024.1394042/full#supplementary-material>

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