

Investigating Student Perceptions towards Mastery-Based Grading in Precalculus

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In this study, mastery-based grading was implemented in three sections of precalculus taught at two institutions. We investigated student perceptions towards this grading system by analyzing math autobiographies written by the students at the beginning of the semester as well as responses to surveys that were distributed at three points in the semester. In this paper, we present our results and discuss the implications to help support students during mastery-based courses.

Keywords: mastery-based grading, precalculus, standards-based grading

Mastery-based grading is not new, but it has begun to receive more attention from undergraduate mathematics educators who are looking for a different way to assign grades that will both accurately reflect their students' progress in the course and temper some of the anxiety and negative attitudes towards mathematics that their students may possess. In this study, we investigated students' (N=21) perceptions of a mastery-based grading scheme being used in a semester-long precalculus course. The use of mastery-based grading is new for many students, so they may need more support to adapt to it. Our results give indications of where this support is needed and in what forms.

Background

Since there are many forms that mastery-based grading can take, we will begin by defining our method of mastery-based grading. We adapted the ideas of Nilson (2015), first developing a set of learning objectives for a precalculus course, then creating a direct link between the objectives in the course and a student's overall grade. In general, students are graded based on how many of the course learning objectives they have mastered. Mastery of the learning objectives can be assessed in a variety of ways, for us this was done using tests, but a key feature of the system is that students do not receive partial credit for partial understanding, rather they must show the grader that they have full proficiency with the objective (Collins, et al., 2019). While students do not earn partial credit, a key element in mastery-based grading is that students are given multiple attempts to demonstrate proficiency on the learning objectives. In addition to the learning objectives, we also developed additional requirements including homework completion and projects to include in the criteria for each grade.

The increase in implementation of mastery-based grading in undergraduate mathematics courses has brought with it an interest in studying the grading scheme and reporting on its effects and outcomes specifically in those contexts. Benefits have been noted in these settings, such as improving students' attitudes towards mathematics, increasing students' confidence in their mathematical abilities (Stange, 2018), and giving the students more control over their final grade (Williams, 2018). Additional benefits were seen by Harsy and Hoofnagle (2020), who found that students felt that their final grade more accurately reflected their knowledge as opposed to grades in a traditional grading environment. Since students know the requirements for each grade from the first day of class, they are able to set goals and make choices to study objectives they feel will allow them to achieve those goals.

There is also evidence that the emphasis that mastery-based grading often puts on reattempting mastery can alleviate stress associated with tests (Stange, 2018) since the reattempts give flexibility for students to continue working on an objective over time. However, there may also be drawbacks to this in terms of student motivation; for example, students may be tempted to put off learning objectives or not take first attempts as seriously as they would in a traditional environment (Weir, 2020). One traditional purpose of mastery-based grading and learning is to allow each student enough time to master the content for the course (Bloom, 1968). However, a course typically has a set ending date, limiting the time available. Instructors will need to think deeply about how they can support their students to set appropriate goals and strategies for success. To do so, it would be useful to understand more about the students' perspectives, which is the goal of this study.

Research Question

The results discussed in this paper are part of a larger study investigating mastery-based grading within college-level precalculus classes conducted by the authors. For the purposes of this paper, we will be discussing our findings related to the following research question: How do students' opinions of mastery-based grading change throughout the semester?

Methodology

This study collected data from three sections of precalculus taught at two different institutions in the same semester. One section was offered as a 3-credit course at a small, private, liberal arts college in the northeast United States (Institution 1) while the other two sections were offered as 4-credit courses at a medium, private university in New England (Institution 2).

Course Structure

The grades for students in the three sections were based on their proficiency on 27 learning objectives as well as their homework completion and their completion of up to two projects. Proficiency on the learning objectives could be shown on five test days, four during a regular class period and one in place of a final exam. Within the 27 objectives were 7 core objectives, which needed to be mastered to pass the class. The questions used for the tests were common across the three sections, as were the homework questions and projects. The base letter grade depended solely on proficiency on objectives and project completion. Students needed to complete one or two projects to earn a B or A in the class, respectively. After the base letter grade was decided, homework scores impacted whether the letter grade would have a plus, minus, or neither attached to it.

Data Collection

The data for the larger study consists of both quantitative and qualitative data, collected through student responses to three surveys, math autobiographies written by the students at the beginning of the semester, homework scores, and test responses and scores. To address the research question above, we use the qualitative data from the surveys and math autobiographies.

Each survey contained various closed- and open-response questions. In this paper, we focus on the analysis of responses to those questions relating to the students' views on the grading used in the class. The first survey was completed in the first two weeks of the semester and students responded to the open-ended question, "What are your first impressions of the grading system in this class?" In the second survey, sent to students after they had taken two tests, the students responded to the open-ended question, "At this point in the semester, what are your impressions

of the grading system in this class?” A third and final survey was sent at the close of the semester, and students responded to four open-ended questions in which they discussed their ideas about the grading structure in the class, those questions being:

1. In preparation for your tests, how did you choose which learning objectives to attempt?
2. Do you believe the grade you will receive in this class accurately represents how much you have learned? Why or why not?
3. Do you think your overall grade would have been better, worse, or the same in this class if you had been graded traditionally? Why?
4. What are your impressions about the grading system used in this class?

Math autobiographies were written by students at the beginning of the semester describing their past experiences with mathematics and their expectations for the current course.

Participants

Students in the three sections of Precalculus were emailed an invitation to participate in each survey. Participating in at least one survey indicated the student’s consent to being a participant in the study, as indicated by filling out a consent form on the survey. A total of 21 students agreed to participate in the study, twelve on Survey 1, thirteen on Survey 2, and ten on Survey 3. Out of the 21 participants, seventeen submitted math autobiographies but only eight of those referred to the grading used in the class. There were 8 participants from Institution 1 and 13 from Institution 2. To protect our participants’ identities, throughout this paper you will see participants referred to by code. Participants at Institution 1 are labeled using the letter N followed by two digits (ex. N20), whereas those at Institution 2 are labeled using the letter R followed by two digits (ex. R01).

Data Analysis

The math autobiographies and survey responses to open ended questions were analyzed using an inductive thematic analysis (Patton, 2002). To investigate the students’ opinions about mastery-based grading at different points in the semester we focused on the students’ initial perceptions, perceptions after taking two tests (midsemester), and their perceptions at the end of the semester.

To analyze the initial impressions about the grading scheme we considered the responses from math autobiographies and from the first survey. To analyze the midsemester impressions that students had about the grading scheme, we analyzed their responses to the question from Survey 2 that was discussed above. Finally, to analyze the students’ opinions about the grading system at the end of the semester we considered the responses to the four open response questions on Survey 3.

Discussion of Results

This section will briefly describe the categories discovered through the analysis of initial impressions, midsemester impressions, and final impressions that students had about the grading scheme.

Initial Impressions

There were four categories that emerged during our analysis of the responses to Survey 1 and the math autobiographies.

Confusing. Responses showed that several students saw the grading system as confusing or strange to them. For example, N20 wrote the grading scheme was “confusing but might be beneficial”. These responses were not surprising since for many students this was the first class in which they had experienced mastery-based grading.

Straight-forward. There were a few students who thought the grading was clear. N50 said, “I love how straight forward, and easy the grading is”. Similarly, R09 emphasized the clarity of the learning objectives, saying, “I think they are really helpful in keeping me focused. Nothing feels jumbled together, I can clearly see what path I need to take.”

Retries. We also saw that students were excited about the ability to retry objectives that they had not shown proficiency on with their first attempt. R12 mentions, “I feel like it is way less stressful for us new incoming students who are use to just having to fail if we do bad on a test ... with the way you grade our tests I get to redeem myself with questions I may get wrong which is very comforting.” This was an aspect of the grading that students seemed to grab on to as a positive aspect of the method, although there was some hesitancy from R06 who said, “I think it’s cool that I can retry topics at my leisure but I hope I don’t mess up on a lot so it snowballs into a disaster.”

Pacing. Students also mention that the grading scheme will give them more freedom and/or independence to complete objectives at their own pace and that there is less stress due to the pacing of the class. N50 says, “I see myself doing well in this class because I’ll be able to go at the pace I want ... I’ll be able to complete [objectives] on my time.”

Midsemester Impressions

Through our analysis of the responses to Survey 2, three categories emerged. Two of the categories were similar to two found in the initial impressions, so we chose to use the same name and definition for them.

Confusing. Even at the midsemester mark, after the students had taken two tests, there were still students who found the grading scheme confusing or strange. However, it seemed that there was some improvement in understanding. R10 said, “I’m very confused by it still, but looking at each individual grade I’ve received helps me calculate what my overall grade is.”

Retries. Students continue to mention the benefit of being able to retry objectives. R10 says, “I love the fact that you can attempt each core objective until you receive the grade you want.”

Stress. A new category that emerged spoke to the students’ perceived stress and anxiety levels in the course, with some students feeling that the level of stress was heightened by the grading scheme and some feeling that it was lessened. From R09, “It makes the class feel more intense, like we have less room for error, and over all, just a really stressful and weird experience.” With an opposing view, R11 says, “I really enjoy it. I think that because of how the tests work and how we’re able to retry problems, my anxiety is much lower for this class.”

End of Semester Impressions

Four categories emerged through our analysis of the four open-response questions from Survey 3. One of the categories, Stress, uses the same name and definition as was found in the midsemester analysis since the ideas were similar.

Stress. A couple students mentioned opposing views on their perceived stress and anxiety levels due to the grading scheme. R01 said, “Objective based learning didn’t help me change how I study, but rather gave me huge amounts of anxiety as my failings kept weighing on me” whereas R02 said, “I think it showed that it is up to us to work hard but also it is okay if not every day is our best day because we get another shot. It took a lot of the anxiety down.”

Strict. Students spoke more specifically about the requirements in the grading system, most likely due to the additional questions included in the final survey. Some students felt that the grading structure was too strict and that they were marked wrong for too small of errors along with not having enough opportunities or ways to show their understanding. R09 felt that “there were small mistakes [they] made from calculation or missing one step of a five part problem where in any other class [they] would have gotten some type of credit for it because [they] clearly understood how to do the problem.” Others mentioned they wanted the projects to count differently, such as R06 saying, “Through doing the projects and homework I have done so much more and the projects will not even be factored into my grade unless I have everything done [that is necessary for an A or B].”

Effort. As we see in some of the examples for Strict, students also discussed that their effort in the class has affected their feelings toward the grading system. Several students felt that the effort they put in for the course was not reflected in their grade, as we saw from R06 above. However, there was also a student, N04, who mentioned that because they always felt they had more chances to complete objectives, they did not put in enough effort: “If it was graded traditionally I think my grade would’ve been higher, because more pressure levied upon me every week meant that I wouldn’t have procrastinated until the last minute to do everything.”

Core. Several students mentioned the core objectives in their responses. This was often relating to how they chose which objectives to study for, stating that they focused on the core objectives first, but we also had students say that they believe the expectation of and focus on mastering the seven core objectives caused them to miss out on other objectives. R09 said, “Most of the class still needs core objectives on the final and are at a high risk of failing.” It is worth noting that of the 18 participants that did not withdraw from the course, only 7 had completed the core objectives prior to the final, so the concern about core has some merit for our sample.

Implications

We believe that investigating students’ perceptions of mastery-based grading is important to understanding how we can support them in our courses. By considering three different points in the semester, we were hoping to gain insight into how support can adapt to the changing concerns of students. Our results indicate that there are some concerns that remain present throughout the semester, while others may emerge later after the students have been able to experience more of the consequences of the grading. Understanding these concerns is useful in planning for a course, especially for instructors who are new to this grading style.

For example, while emphasizing the opportunities for students to retry objectives can alleviate some of their concerns early in the semester, it may be beneficial to have specific recommendations about how to take advantage of these opportunities so that the pressure is not just pushed to the end of the course or due date. This agrees with findings by Matz, Derry, Bennett, LaRose, and Hayward (2022), who found that the use of behavioral nudges can lead to better outcomes for students. In their study, personalized email reminders were sent prior to assessment due dates. Other ideas could be to have class discussions about study strategies, hold individual meetings to plan for future assessments, or to structure the course with some intermediate deadlines.

These results represent a portion of the data we collected. In addition to the math autobiographies and survey responses, we also collected tests, homework scores, projects, and grades. We hope the RUME community can provide insights on how to further explore these results and make connections to the other data sources.

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