Closing the Homework Feedback Loop, an Alternative Approach to Homework Grading

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Abstract:
This paper studies an alternative grading method for homework assignments designed to increase student learning and motivation. The method emphasizes correct completion of student work, even if multiple turn-ins are required. After submitting homework, the instructor checks the accuracy of the work. Incorrect work is returned to the students the morning after its initial due date. Students are then given a day or two to correct their work and re-submit. This cycle is repeated as many times as necessary at the teacher’s discretion. Grades are based on the number of iterations required for the work to be correct. Results from the study show that while student learning was not measurably affected, student motivation to perform well on the homework assignments increased. This rise in motivation may be dependent on the context within with the method is employed—it seems to work better for higher level technical electives than for larger common courses.

Introduction:
Homework is used across virtually all disciplines to achieve various learning goals. During a typical undergraduate experience, students will spend a large portion of their out-of-class work on homework assignments. Thus, it is one of the primary methods used to facilitate student learning. In this study, an alternative grading method (AGM) for homework was designed in order to give homework more impact. The basic concept behind the AGM is to require students to work on homework until they get it 100% correct (or nearly so). Their grade is based primarily on how long it takes them to get everything right after a certain deadline. This requires the grader to return homework sets the day after they are turned in, usually from a centrally located drop-box. The students then re-work or correct missed problems and resubmit within an appropriate deadline.

This study is based on the hypothesis that the Alternative Grading Method increases both student learning and student motivation to successfully complete homework assignments. It increases student learning through forced mastery of the material, by intentionally closing the feedback loop for those students who need it, and by increasing cooperative learning with either faculty or student-peers. It forces students to review missed material early enough for them to learn from it. Too often, students wait until the night before a test to look at old homework sets, which does not afford them enough time to learn from their mistakes. Thus, they miss the valuable learning opportunity of correcting mistakes and misconceptions and setting the record straight in their own mind.

The AGM increases motivation through a number of direct and indirect means. First, it helps to develop a learning orientation rather than a grading orientation [1]. The grade is a by-product of the process, not the goal. The goal is to master the material. Second, the AGM eliminates half-hearted efforts by students with a “good enough” attitude in the face of competing academic demands and other distractions. It incentivizes accuracy in addition to completion by applying time penalties rather than point penalties. Thus, it seeks to defeat the “good enough” mentality mentioned previously. It also communicates high expectations of students, and discourages the learned helplessness that some students are prone to adopt [2]. Lastly, it communicates the importance of the material—if a student must get it right, it must be important! Thus, the increased level of motivation is not necessarily due to an elevated desire to achieve or increased interest in the subject matter; rather, it springs primarily from the fact that the students are stuck with their work until they get it right—a dynamic they will often face later in life in either graduate study or professional practice.

Literature Survey:
Neither faculty nor students relish many aspects of homework. Walvoord and Anderson, in their extensive treatment of assignments and grading at the college level, encourage instructors to “Give up the false hope of a perfect, simple system” [3]. However, that does not mean that an appropriate level of thought and planning should be omitted. Indeed, Walvoord and Anderson assert that one should “…plan your grading from the first moment you begin planning the course” [3]. This planning, however, should not be limited to the type and number of assignments—the grading technique employed should also be given due consideration.

Chickering and Gamson’s well-cited list of seven principles for good practice in undergraduate education are also a good source for evaluating any new teaching method [4]. A quick review of the seven principles shows that the AGM directly increases three principles (encourages contact between faculty and students, gives prompt feedback, and emphasizes time on
task) and indirectly encourages three others (develop cooperation among students, encourages active learning, and communicates high expectations). Additionally, Davis encourages faculty to “give students a chance to improve their writing by rewriting their papers” [5]. This opportunity should also be afforded those students who need the opportunity to improve their problem-solving skills as well. Wong-Dodge and Ryan studied the effect of allowing students to self-correct their own exams, showing that additional learning occurred after the test [6]. The AGM seeks to leverage self-correction as well, but preferably before the exam.

Interestingly, a conversation about how error correction on homework should be done has been going on for the last decade in the Second Language community. Chandler reports on a number of studies conducted in the early part of this decade [7]. Her own studies analyzed the improvements in writing for two groups of students—both were given the same error feedback on their written work, but only one group was required to correct their work and re-submit. Chandler discovered that “…the accuracy of student writing over 10 weeks improved significantly more if these … college students were required to correct their errors than if they were not” [7]. Indeed, her analysis of the students’ work demonstrated that “…if students did not revise their writing based on feedback about errors, having teachers mark errors was equivalent to giving no error feedback since the students’ new writing did not increase in correctness over one semester” [7].

One common difficulty in analyzing such situations is the fact that the group required to correct their homework will almost certainly have had more practice, skewing the proficiency in favor of the group that had forced corrections simply because they spent more time working on the material. Chandler noted the following:

“In summary, mere practice resulted in a significant increase in fluency for both groups; that is, at the end of the semester they were able to write the same amount and kind of text (in the same context of a homework assignment) in much less time, according to self-reports. However, mere practice without error correction did not produce more correct subsequent writing, whereas when students corrected their errors before writing the next assignment, their first drafts became more accurate over the semester” [7].

Chandler’s results clearly point to the efficacy of forced error correction in teaching writing to non-native speakers of English. One would expect that a similar technique would yield similar results with undergraduate students who are learning various engineering disciplines for the first time.

Another aspect of homework grading that stood out in the literature was the need to quickly provide feedback to students on their work. Rock and Thead describe this need in elementary students [8]. The out-of-class assignment method used by Morse allows student to receive feedback the very next class [9]. Clearly, the feedback needs to arrive while the memory of the work performed is still fresh. Although important, the turn-around time is not the only important consideration. Walvoord and Anderson encourage instructors to consider making lengthy corrections on non-graded assignments and much shorter corrections on assignments that received a grade, stating that “Often a teachable moment is when there is still something the student can do to improve the grade on a live assignment” [3]. Although this is quite true from the standpoint of traditional homework assignments, the AGM does not artificially divorce the grading process and the feedback process. Rather, the two are joined together, and the feedback loop is closed.

Research Method:

In order to determine whether student learning and motivation increases through the use of the AGM, several sources of data will be used. The learning outcomes will be analyzed using test scores, and the motivational outcomes will be assessed using classroom assessment tools, primarily surveys.

Unlike the experience of Chandler, the current study generally observed no significant increase in test scores for material that was covered on homework assignments using the Alternative Grading Method. This was found to be the case when considering three different courses and two different instructors. However, the student motivation to perform and their acceptance of the method was generally high, but was observed to vary from course to course.

The AGM was conducted in three different courses: ME311, Thermal-Fluid Systems I, a large common core course that most engineering majors at the US Military academy must take; ME387, Introduction to Applied Aerodynamics, a technical elective that only aeronautical engineering students take their junior year; and ME481, the follow-on technical elective for ME387. In the core course, the study compares the performance of 15 students against the remaining 159 students enrolled in the course. For the technical elective courses, 66 students took part in the study over 2 semesters, and their performance was compared to three years worth of student performance on similar events, comprising 130 students.

The alternative grading method was employed whenever repeated cycles of re-worked solutions would not interfere with another large graded event such as an exam or a laboratory exercise. Thus, it was utilized in two of five homework assignments in ME387, two of seven assignments in ME311, and in three of six homework sets in ME481. Each homework set typically accompanies a block of material that is somewhat stand-alone, such that scores from each problem on mid-term and final exams can be traced back to the corresponding block of homework. As such, scores from each block on an exam can easily be compared to historical trends to determine if scores are higher and therefore more learning took place.

Results and discussion: Student Learning and Retention
In ME387, the records of both mid-term exams were compared to the grades on the same events in years past. In ME311 and ME481, only the final exams were broken out to track performance on the AGM. The content and difficulty of these exams changes little from year to year. As mentioned earlier, no conclusions can be made concerning the efficacy of the alternative grading method per Table I. In almost half the case studies, the control group (that did not experience the AGM) scored better than the study group. Even in those situations where the scores were higher for the experimental group, a two sample t-test shows that each p-factor for these experiments was well above the 0.05 p-factor required for statistical validity.

Table I. Results of Exam Questions covered by the AGM

<table>
<thead>
<tr>
<th>Graded event</th>
<th>Control Group</th>
<th>AGM Group</th>
<th>P-factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mid-term 1, elective</td>
<td>88.0%</td>
<td>73.2%</td>
<td>0.0617</td>
</tr>
<tr>
<td>Mid-term 2, elective</td>
<td>84.1%</td>
<td>86.2%</td>
<td>0.21</td>
</tr>
<tr>
<td>Final 1, elective 1</td>
<td>85.6%</td>
<td>86.0%</td>
<td>0.47</td>
</tr>
<tr>
<td>Final 2, elective 1</td>
<td>95.2%</td>
<td>90.8%</td>
<td>0.06</td>
</tr>
<tr>
<td>Final 3, elective 2</td>
<td>91.1%</td>
<td>84.8%</td>
<td>0.021</td>
</tr>
<tr>
<td>Final 4, elective 2</td>
<td>92.8%</td>
<td>89.1%</td>
<td>0.175</td>
</tr>
<tr>
<td>Final 5, elective 2</td>
<td>94.0%</td>
<td>92.0%</td>
<td>0.251</td>
</tr>
<tr>
<td>Final 6, elective 2</td>
<td>87.6%</td>
<td>80.5%</td>
<td>0.069</td>
</tr>
<tr>
<td>Final 7, elective 2</td>
<td>89.9%</td>
<td>92.2%</td>
<td>0.212</td>
</tr>
<tr>
<td>Final 1, core course</td>
<td>92.4%</td>
<td>94.6%</td>
<td>0.108</td>
</tr>
<tr>
<td>Final 1, core course</td>
<td>84.7%</td>
<td>82.2%</td>
<td>0.22</td>
</tr>
</tbody>
</table>

Results and discussion: Student Motivation and Other Factors

Since the Alternative Grading Method did not increase student performance on graded events, it is necessary to examine its effect on student motivation, collaborative learning, and instructor workload. Students were surveyed at several key points about their attitudes concerning the AGM at several points throughout the semester—one immediately after the conclusion of the AGM exercise, one several weeks after the AGM event, and finally on the course end survey.

One impetus for attempting the AGM technique was a survey that was conducted about junior-level engineering students’ general attitude toward homework. Given the many competing demands on students’ time, this survey attempted to determine at what point in time students cease working on homework sets. The survey was performed on 63 students across five sections of a large, junior-level course that all mechanical engineering majors are required to take. In short, the survey demonstrated that an average of 41% of the time, students will submit homework sets that they know to be incomplete or in error after they felt that they have spent too much time on their work. The results are presented in Figure 1. The alternative grading method was designed in-part to prevent this sort of attitude from affecting the performance on both homework sets and any follow-on exams.

The motivational features of the AGM were analyzed using several methods: open ended questions (provide 3 sustains/improves about the course overall), specifically asking students which grading method they preferred and why, and asking 4 questions to measure the effects of the AGM (agreement scale), and finally asking two questions on the course end survey (agreement scale). In one course, the sections were permitted to vote about whether they wanted to use the AGM on a particular homework set (before it was assigned). After analyzing the data, it became clear that the effect of motivation on each group of students was strikingly different. The students in the elective course liked the technique more (Figure 2) and reported a higher bump in motivation (Figure 3). However, the students in the core course did not like the technique as much and also reported a smaller increase in motivation. Additionally, the students in each class were asked completely open ended recommendations for sustaining or improving features in the course. In the elective courses the AGM was much more highly regarded, mentioned four and five times as a sustain, and only mentioned once as an improve across two different years. The students in the core course didn’t mention the AGM at all when given the opportunity for undirected feedback.
Ironically, the students felt most strongly that the AGM helped them to learn the material better, a conclusion that is not supported by test scores. However, students are a good judge of their own motivation, and they reported a slight positive increase in motivation as well as a slight positive increase in the amount of collaboration. Rudimentary data about collaboration was collected, but no significant trends were identified.

In addition to voting for their preferred grading method, the students were also asked why they felt the way they did. The first notable point was that the overwhelming majority of students who stated that they preferred standard grading arrangements cited the extra time required to complete the AGM iterations as a key deciding factor in swaying their preference. A few others also cited the frustration of having to revisit material more than once. However, many of the positive comments are revealing (Figure 4). These comments reveal two things. First, the students appeared to value the opportunity to learn from their mistakes and several admitted that they wouldn’t revisit their homework problems until the exam, if at all. Secondly, it potentially reveals that students are apt to echo the rationales provided to them when the method is described. This may “taint” the data, but it also demonstrates that student acceptance of the method may be significantly swayed by how it is presented in the first place.
Figure 5 and Figure 2 show that student enthusiasm for the AGM might tend to erode over time. The third and fifth columns in Figure 2 demonstrate that fewer students preferred the second alternative grading homework five weeks after the first one. The course end feedback depicted in Figure 5, which covers the same group of students over 2 semesters, also demonstrates that the AGM was not as highly rated the second semester that the students used it.

![Figure 5](image.png)

**Figure 5** Course end survey results concerning student attitudes about the AGM

Although many students complained about the time that the AGM took, no consistent increase in out-of-class time was observed when reviewing standard time survey data that is collected for all engineering classes at West Point. Engineering classes at West Point anonymously collect data on the amount of out-of-class time was spent on each course for each lesson. Using this data, the elective course under consideration was compared to the average of the last three years, and for the core course, the AGM sections are compared to the rest of the course average (Figure 6). Only the three lessons surrounding the due date of each AGM homework are analyzed (assuming that the increased time investment would manifest on both sides of the due date). Although there is a notable increase in out of class time spent for the homework set due on lesson 6, none of the other events register significantly above the mean. The content and scope of each homework was comparable, so the differences in time should not be affected by the assignment itself.

Another potential benefit of the AGM is that every student ultimately possesses their own copy of the solution—they do not have to go to a solutions room or access a solution online when they are preparing for exams. Since solutions to all homework sets and exams are posted on Blackboard, student views of the various solutions can be tracked. If the solutions for standard homework sets are viewed more often than the AGM assignments, there would be evidence that the students gain a benefit from having their own solution. This benefit would be even more pronounced if the posted solutions are mostly viewed the night prior to an exam. Although such statistics were tracked, no clear trends are evident. In different semesters, non-AGM assignments were accessed only two and three times apiece. In another semester, one AGM homework...
solution was accessed six times, and the other assignments were never accessed at all. Interestingly, however, is how little the students access the solutions to homework sets and exams. Although far from conclusive, this data further suggests the “water under the bridge” attitude that many students adopt about their academic work. Of course, if students are sharing solutions among themselves, either from Blackboard or their own solutions, this activity will not be captured using Blackboard statistics tracking feature.

Results and Discussion: Further Discussion and Interpretation

An additional concern that many faculty will have concerning this method is the apparently large investment in time spent grading each homework set multiple times. This factor is strongly influenced by how the AGM is conducted. If student work is returned with little to no marks, the method can be quite efficient for faculty. If the instructor wishes to direct the student to where he or she went wrong, the commitment can quickly exceed the time typically spent grading in the normal fashion. The question remains whether students benefit more from finding their own mistakes and correcting them, and the current work did not address that question. Finally, it is possible that more students will seek help from the instructor during office hours than during non AGM periods of the course.

The method may be attractive to faculty for other reasons. For any institution who is training engineers to serve society as professional engineers in the workplace, the attitudes about work that are adopted by students may be affected by their academic experience. In short, the amount, length, or difficulty of homework causes many engineering students to adopt a “take it or leave it” approach or a “good enough” attitude about their homework once they have expended a certain amount of effort. This experience in college can unintentionally foster this attitude toward solving engineering problems in general—a dangerous mode of interacting with engineering problems. The AGM can reduce this tendency because the AGM forces students to work until they get each problem right. This reinforces the notion that each problem is important and that only correct answers are satisfactory, regardless of the time investment required.

The extent to which this technique is received is also likely to be strongly predicated on how it is presented. This may be an area for future research. In particular, if the method is presented in the tone of “I am going to require you to do these problems until I know that you can do them, and your grade is based on how long it takes you get it right,” the method is likely to be less well received. However, if one adopts the tone of “I believe that the best and deepest learning comes from re-visiting problems that one misses…” or even, “the best learning experiences I had in my own schooling occurred when I struggled through material I didn’t understand at first…” This will at least put a positive face on the implementation of the AGM.

Conclusion:

In short, the alternate grading method does not demonstrably increase student learning or retention as measured by student performance on exams. However, it has the potential to significantly increase student motivation to perform on homework and to dedicate the amount of time required to successfully complete the homework. It also appears to increase the occurrence of collaborative learning, although this was not directly measured.

If the AGM is used primarily to increase student motivation, care must be taken as when it is best to be used. Students appear to be capable of developing immunity to the technique. Thus, it should only be used on material that is deemed seminal to the course (and follow-on courses) or material that historically gives a high rate of student failure, resistance, or misunderstanding. Additionally, if an increase in student motivation is desired, the technique is more likely to work when the students have a higher inherent interest in the course, such as is often the case with upper-level elective courses.

If not used exclusively throughout a course, the timing of using the AGM is an important consideration. In all courses under examination in this study, the AGM was only used where it would fit nicely into the flow of other out-of-class graded activities (labs, design reports, etc) in the course, of which there are many. Unfortunately, this meant that sometimes the AGM was used on elementary material. In some senses this is justified because elementary material is often fundamental material that each student needs to understand to a high level of precision. However, the technique could also used specifically when courses address material that traditionally gives a challenge to students or that routinely reduces student morale or interest. In either case, the alternative grading method deserves serious consideration by anyone who is dissatisfied with their current homework arrangement.

References


