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How to Make Testing and Grading Non-Confrontational: Towards Applying Loving Kindness to Testing and Grading

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Abstract

Students and teachers have a common goal: that the students successfully learn all the required material. At first glance, the existence of a common goal should result in a conflict-free environment. However, in practice, the current education process has become very confrontational, especially during testing and grading: students come up with more and more sophisticated ways of cheating, while instructors use more and more complex tools to detect this cheating. Do we need to continue this arms race? Would it not be better to use the ideas of loving kindness and come up with a conflict-free teaching environment? In this paper, we analyze the reasons for the current conflicts, and we use this analyze to come up with a non-confrontational way of performing testing and grading, a way that we actually tested in a class.

Keywords: education, non-confrontational, uncertainty of student answers

1 Formulation of the Problem

Teachers and students have a common goal. In education, teachers and students share the same goal: for students to learn the material. From this viewpoint, there does not seem to be any clear conflict between teachers and students – and therefore should not be any conflict between them.

In practice, the relation between teachers and students is often confrontational. While theoretically, there seems to be no reason for a conflict between teachers and students, in practice, the relation between them is often confrontational: some students cheat, and instructors spend time and efforts catching this teaching.

An ideal solution would be to avoid confrontation. Instead of designing newer and newer methods for detecting cheating, why not try to avoid confrontations in the first place, why not apply the general ideas of loving kindness – see, e.g., [2].

In this paper, we should that such non-confrontational testing and grading is indeed possible. One of us (F.Z.) have used these ideas when teaching the Introduction to Computing for Scientists and Engineers course.

2 What is the Reason for Conflict Situations?

Why cheating? To eliminate cheating and come up with non-confrontational testing and grading, let us recall where cheating comes from.

- Cheating sometimes happens during homeworks: instead of doing the homework on his or her own, a student uses someone's help.

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- Cheating sometimes occurs during tests: contrary to the requirements, students use cheat sheets or notes that contain the information that they are supposed to know. Sometimes, students get illegal access to last semester's tests which are very similar to this semester's.

Not only there is cheating on the tests, students consider the requirement not to have any notes on the test to be unfair: indeed, the goal is to prepare students for the real-life work environment, and in this environment, what is important is the result. If a professional software designer needs to check with the textbook he is free to do so – there is no sense in making him memorize everything by heart.

Other sources of discontent. Other sources of discontent come from the fact that since the students consider learning the main objective, they consider it to be fair to get a final grade reflecting the final state of the knowledge. However, in the grading system used in the US, the final grade for the class is a linear combination of grades for all the assignments and test, not only the final exam. As a result, even if the student learned everything perfectly well by the time of the final exam, this student may still get a B grade if his or her grades on the midterm exam were low.

This problem does not appear in the grading system used, e.g., in Russia, where the final grade is determined only by the student's grade on the final exam, but this approach has another problem: since the students do not have any grade-related incentive to study hard during the semester, some students procrastinate, start studying too late, and, as a result, do not learn much – and get a bad grade. What makes the Russian-style system even worse is that the student may not even know that he or she is falling behind, or at least which topics is he or she seriously behind.

How can we avoid all these problems?

3 How to Avoid Conflict Situations: Towards a Conflict-Free Teaching Environment

Now that we know where the conflicts come from, we can use these descriptions to eliminate these conflicts and create a conflict-free teaching environment.

How to eliminate cheating by eliminating incentive for cheating. Since homeworks provide an incentive for cheating, one thing we should do to create a no-conflict friendly environment is to eliminate homeworks-for-grading. Grades should come only from quizzes and tests, where the instructor can easily check that students do not collaborate between themselves.

The only way how a student can cheat during the test or quiz is by having an email or phone contact with an outside friend. To avoid this, we follow the usual practice of disallowing email and phone communications during the test or quiz.

During quizzes and tests, the incentive for cheating comes from the prohibition to use cheat sheets, notes, textbooks, etc. A natural solution is therefore to allow the students to use any material they want.

One may ask: in this case, will not the students be able to come with a poor knowledge and still pass the test by looking up answers? Yes, if they had unlimited time, but during the limited time of a test, there is no easy way to answer all the questions if the student still needs to learn the material.

It is also important to make sure that the students do not get an unfair advantage by learning last semester's quizzes and tests. Since it is possible that some students will get these quizzes and tests – e.g., if they have friends who took this class the previous semester – the only way to make the situation fair is to always post all the tests and quizzes after these tests – for everyone to see.

Of course, this creates an extra burden on the instructor who needs to come up with new tests and quizzes every semester – but we believe that this is a small price to pay for creating a conflict-free environment, in which both the teacher and the students strive together towards a common goal.

How to take care of different learning styles. As we have mentioned earlier, another source of conflict is the fact that the overall class grade assumes a certain path of learning. Individual students may have different learning styles. In the ideal world, what should matter is how well the student learned the material at the end of the class, and not how well the student learned the material from Chapter 1 by the time of the first test. If a student did not know this material well by that time, but learned it later, why not give this student the full credit for this material?

From this viewpoint, we believe that a fair system is when the grade for the class is determined only by the student's knowledge at the end of the class, by the time of the final exam. This does not mean, however, that the student will remain clueless about the intermediate states of his knowledge – we follow an idea of Dr. Eric Freudenthal from the University of Texas at El Paso, that after each quiz or test, the student will get grades describing his or her current state of knowledge on each of the corresponding topics. This way, the student gets a good idea about his or her strengths and deficiencies – and thus, a good indication of how much time is needed to study the remaining topics.

4 Resulting Conflict-Free Testing and Grading Strategy

Description of the strategy. As a result, we arrive at the following testing and grading strategy:

- no graded homeworks; the only purpose of homeworks is to help students learn and to help them prepare for the test;
- on the quizzes and tests, it is allowed to use cheat-sheets, class notes, textbook, etc.; as usual, students are not allowed to communicate with outside world during the test; of course, the test must be sufficiently fast-paced to make sure that the students cannot just learn the material during the test time;
- after each test or quiz, this test or quiz is posted on the web, for everyone to see;
- the grade for the class is determined only by the grade on the final exam; after each intermediate quiz and test, the students get an indication, for each of the corresponding class topics, how skilled they are in this particular topic.

How we used this strategy. One of us (F.Z.) used this strategy when teaching the Introduction to Computing for Scientists and Engineers course at the University of Texas at El Paso. Anecdotal evidence is that there was much less feeling of confrontation than usual.

5 What Next?

It is important to quantitatively evaluate the above strategy. To make sure that we have not missed any potential sources of conflict, it is important to supplement our anecdotal evaluation of our supposedly conflict-free strategy by a quantitative analysis.

Beyond usual grading: need to estimate the students' degree of confidence in their answers. In the usual grading, we only take into account whether the answer is correct or not. Ideally, we should also take into account how confident the student is in the corresponding answer.

If a student is not confident at all, selected the answer randomly, and accidentally got the right answer, this is not as good as when the student is absolutely confident in the correct answer. In general, the more confident the student is in the correct answer, the better. On the other hand, when the student is absolutely confident in the wrong answer, it is much worse than if he or she selected this answer at random – for example, if a medical doctor is absolutely sure about the wrong diagnosis, it may lead to a serious mis-treatment, but if the doctor is uncertain, he or she will most probably solicit the second opinion and thus, the results will not be so bad.

The problem is that the only way to elicit the student's degree of confidence is to ask the student to supply this degree with the answer. In view of our desire to strive for a conflict-free educational environment, we need to come up with the corresponding grading scheme that would encourage students to supply correct degrees – and thus, to avoid cheating. This problem was solved in [1]. For completeness, we reproduce the main result from this paper as an appendix.

A How to Take into Account Student's Degree of Confidence when Grading Exams

Formulation of the problem in precise terms. Let us formulate the problem of designing such a grading scheme in precise terms.

Let us assume that we have a question with n possible answers of which only one is correct. Instead of simply picking one of n possible answers, a student reports his/her degrees of confidence $q_1, \ldots, q_n$ in each of the answers. These degrees may be, e.g., subjective probabilities that the corresponding answer is correct, in which case these probabilities should add up to 1:

$$q_1 + \cdots + q_n = 1. \tag{1}$$

We want to make the number of points awarded to the student dependent on the degree q that this student assigned to the correct answer: the larger this degree, the more points the student gets. Let us denote the number of points assigned to the students by $f(q)$.

Our objective is to select the function $f(q)$ in such a way that the student is encouraged to report his or her true degrees of confidence. Let $p_1, \ldots, p_n$ be actual student's degrees of confidence, for which

$$p_1 + \cdots + p_n = 1. \tag{2}$$

If the student reports his or her actual degrees of confidence, then for each i, with probability p_i, the i-th answer is correct and the student gets $f(p_i)$ points. In this case, the expected number of points awarded to the student is equal to the sum

$$p_1 \cdot f(p_1) + \cdots + p_n \cdot f(p_n). \tag{3}$$

If instead, the student reports different degrees $q_1, \ldots, q_n$, then for each i, with probability p_i, the i-th answer is correct and the student gets $f(q_i)$ points. In this case the expected number of points will be equal to

$$p_1 \cdot f(q_1) + \cdots + p_n \cdot f(q_n). \tag{4}$$

We need to select the function $f(q)$ in such a way that for the fixed values $p_1, \ldots, p_n$, the largest possible expected value (4) is attained when the students reports the actual degrees, i.e., when $q_i = p_i$ for all i.

Analysis of the problem. Our goal is to find the function $f(q)$ for which the values $q_i = p_i$ for all i solve the problem of maximizing the sum (4) under the constraint (1). By using the Lagrange multiplier method, we can reduce this constraint optimization problem to an unconstrained problem of maximizing the expression

$$L \stackrel{\text{def}}{=} p_1 \cdot f(q_1) + \cdots + p_n \cdot f(q_n) + \lambda \cdot (q_1 + \cdots + q_n - 1), \tag{5}$$

where λ is the Lagrange multiplier. At the maximum, the partial derivatives of the function L are equal to 0. Differentiating the expression (5) with respect to q_i and equating the derivatives to 0, we get

$$p_i \cdot f'(q_i) + \lambda = 0 \text{ when } q_i = p_i, \tag{6}$$

where f' denotes the derivative of the function $f(q)$. Thus,

$$p_i \cdot f'(p_i) + \lambda = 0. \tag{7}$$

In other words, the product $p_i \cdot f'(p_i)$ is equal to $-\lambda$ and so, is the same for all i. This means that the product $p \cdot f'(p)$ is a constant which does not depend on p:

$$p \cdot \frac{df}{dp} = \text{const}. \tag{8}$$

If we multiply both sides of this formula by dp and divide both sides by p, we separate the variables f and p and get the following equality:

$$df = \text{const} \cdot \frac{dp}{p}. \tag{9}$$

Integrating both sides of this equality, we conclude that

$$f(p) = \text{const} \cdot \ln(p) + C \tag{10}$$

for some constant C.

Thus, we arrive at the following conclusion.

Conclusion. We want to take into account, when grading the student's answers, the student's degree of confidence in different answers. We want to take these degrees of certainty into account in such a way that the students are incentivized to report correct degrees of confidence.

Our result is that this is possible only in one case: when the number of points $f(p)$ awarded to an answer is proportional to the logarithm $\ln(p)$ of the student's degree of confidence in the correct answer.

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