QUIZ CORRECTIONS: Improving Learning by Encouraging Students to Reflect on Their Mistakes

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INTRODUCTION

Many college instructors want students to make an effort to learn from mistakes on quizzes and exams, but do not think that students typically do this.[1]

In a survey of introductory engineering students, only 21% indicated that they would revisit an exam after taking it. Many further stated that this would only be if the final were cumulative.[2]

In this poster we describe an assignment where students correct errors on their exams as a way to learn from their mistakes.

THEORETICAL UNDERPINNINGS

Formative Assessment: Feedback (and student processing of feedback) is the most important part of learning.

Metacognition: An ability to think about one's own thinking and monitor one's current level of understanding is essential for learning.

Personal Epistemology: Student beliefs about knowledge and learning have a significant effect on their approaches to learning and their learning outcomes.

Understanding Students: Effective teachers understand where their students are, what they are thinking, and how they are interpreting information provided in the course.

Variations in the use of assessment corrections

	What students are asked to do	When do students get instructor solutions?	Grading	Incentive	When used
Brown	Correct mistakes and explain why they were made	Before doing quiz corrections	0, 1, 2	Points added to exam score	On all tests, but not final
Harper	Correct mistakes, briefly explain errors	After doing quiz corrections	All, half, or nothing	Counts as a homework assignment	On all tests but final
Henderson	Diagnose: Identify what went wrong Generalize: beyond the specific problem	Before doing quiz corrections	All or nothing	Increase quiz score by 50% of missed points	All weekly quizzes, but not exams

Bob Brown, Case Western Reserve University:

When you get your exam back, please go through it and briefly correct all of your mistakes: squeeze the corrections right onto the exam answer sheets themselves - use a *different colored pencil or pen so we can identify your new remarks*. Also, explain in only a few words (again, squeeze them right onto the exam answer sheets) why you made the mistakes you did (e.g., you misread the problem, you made an algebra error, you thought something was conserved that wasn't, etc.) Please don't just say "you didn't have a clue;" you very likely can tell us more than that about what stopped you from proceeding further. Hand back the corrected and explained exam with your other homework and we'll get it back to you when we give you back that homework after grading. You - and we - will learn from this!

Kathy Harper, Denison University:

Syllabus description
Midterm corrections: To assist you in using your graded midterm exams as learning tools, I require that you turn in corrections to any problems you missed. These will be due at the class meeting after the exams are handed back. While writing these corrections, you may consult with any resources, including the book, classmates, or instructors. You will receive all 10 points for an honest effort. If your score on the midterm is 90% or greater, you do not need to submit the corrections and will receive 10/10 for the assignment.

E-mail
Today you received your graded exams. As you've seen in the syllabus and heard in class, you are to look over the exam and turn in corrections to anything you missed. You can consult any resources, including the book, other students, the internet, and anyone on the instructional staff. I want you to understand what you did wrong so that you will not make the same mistakes again later! Please write your corrections on separate paper, and include a short statement about why what you did originally was wrong. Submit the corrections, along with your original exam, at the beginning of class on Wednesday.

Charles Henderson, Western Michigan University:

Quizzes are designed to be a learning experience. Therefore, you can improve your quiz score by carefully reflecting on your performance and learning from it. Completing this assignment appropriately will allow you to increase your quiz score by half of the points that you missed. This is an all-or-nothing assignment. It is intended only for those students who are interested in making a serious effort to improve their understanding. If it is not done well, you will not receive any additional points.

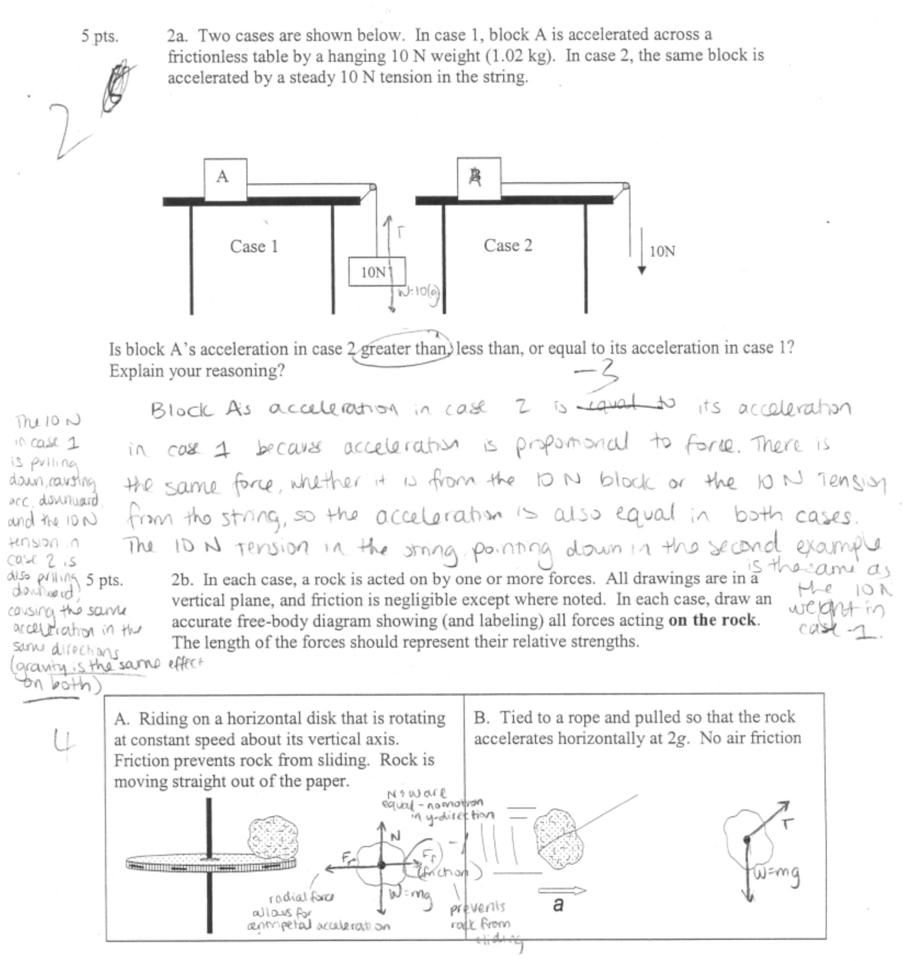
To receive credit for your corrections, you need to address the following **two phases** for **each** question or problem that you did not receive full credit on. See detailed description of each in the separate document.

Diagnosis Phase (DP) – Identify what went wrong.
Generalization Phase (GP) – Learn from your mistakes by generalizing beyond the specific problem.

Please **type** your answers below and use additional pages as necessary. Be sure to attach your quiz paper so I know what you are talking about.

Example of Student Quiz Correction

(Student received a 'C' in the course. Some marks are from the grader.)


5 pts. 2a. Two cases are shown below. In case 1, block A is accelerated across a frictionless table by a hanging 10 N weight (1.02 kg). In case 2, the same block is accelerated by a steady 10 N tension in the string.

Is block A's acceleration in case 2 greater than, less than, or equal to its acceleration in case 1? Explain your reasoning?

5 pts. 2b. In each case, a rock is acted on by one or more forces. All drawings are in a vertical plane, and friction is negligible except where noted. In each case, draw an accurate free-body diagram showing (and labeling) all forces acting **on the rock**. The length of the forces should represent their relative strengths.

A. Riding on a horizontal disk that is rotating at constant speed about its vertical axis. Friction prevents rock from sliding. Rock is moving straight out of the paper.

B. Tied to a rope and pulled so that the rock accelerates horizontally at 2*g*. No air friction

(2) In problem 2a, I answered the way I did because I knew that acceleration was proportional to force, but for some reason I wasn't thinking and thought that this meant acceleration was equal to force. Since I knew that the net forces that were acting on the system were the same, I also assumed that the accelerations were equal too. I did not do the free body diagram and write the formula that the net force equals the mass times the acceleration. Had I done this, I would have been able to see that the acceleration and masses are not equal. Since both systems equal the same net force, 10N, and system number one has a greater mass, if I would have plugged in these values into the equations, I would have been able to see that the acceleration in case 2 has to be larger, since the mass is less. Since the mass in 2 is less, the acceleration has to be greater in order to make the net forces the same, which we know they are by simply seeing the picture. I have learned that it is vital to write Newtons Second Law when solving a problem, and to actually use the fact that it states the sum of forces is equal to the mass times the acceleration. I now know for future problems that although mass is proportional to acceleration, this does not mean they are equal.

In problem 2b, I answered the way I did because I assumed that there had to be a frictional force acting in the opposite direction of the radial force, in order for the rock to not slide off of the disk. I did not use my knowledge that the force of friction that points towards the center of the circle IS in fact the force that keeps thw rock from sliding off the disk. I did not recognize this information given in the problem- that said friction prevents rock from sliding. Since the rock is at a constant speed, we know there is a radial force towards the center, and this force is the frictional force.

EFFECTIVENESS

Although we have not conducted experiments to evaluate the effectiveness of assessment corrections (i.e., no control groups were used), we consistently find that:

A)Students have large gains in conceptual understanding in classes where assessment corrections are used.

CSEM scores for quiz correction courses (students who took both pre and post CSEM)

	W04 (OSU)	F04 (WMU)	W05 (OSU)	F06 (WMU)	Comparison Data from "traditional" courses[3]
	N = 194	N = 46	N = 210	N = 107	
CSEM Pre	33.8 ± 1.0%	32.0 ± 1.5%	33.2 ± 1.2%	28.2 ± 1.0%	31 ± 0.3%
CSEM Post	71.0 ± 1.1%	64.2 ± 2.1%	70.2 ± 1.1%	61.7 ± 1.4%	47 ± 0.5%
<g>	<g> = .56	<g> = .47	<g> = .55	<g> = 0.47	<g> = .23

B) Students believe that assessment corrections help them learn.

Student rating of the extent that various course components helped them learn. (From Henderson's calc-based intro physics course, Fall 2004.)[

Component of Course	% of students rating as 'extremely helpful' for their learning of physics
Quiz Corrections	50
Use of Main Ideas	45
Web site	33
Group Work	30
HW Exercises	30
HW Problems	23
Lectures	23
Written HW	20
Quiz/Exam	18
Office Hours	15
Text	11
Problem Solution Requirements	5
Reading Question	5

C) Assessment corrections appear to lead to more meaningful learning for many students, and also more effective use of class time.

- Students ask thoughtful questions about the physics.
- More students visit office hours after exam than before.
- Students take corrections assignment more seriously than general homework.
- Less class time is spent going over exam/ quizzes.

REFERENCES

1. Yerushalmi, Henderson, Heller, Heller & Kuo, *PRST-PER* **3** (2), 020109 (2007).
2. Harper, Brown & Finnerty, 2004 AAPT Winter Meeting.
3. Maloney, O'Kuma, Hieggelke & Van Heuvelen, AJP **69** (7), S12-S23 (2001).