Standards Based Grading in AP Calculus Classes

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Introduction

Standards Based Grading (SBG) is a system that assesses students on their understanding of individual topics. Instead of earning one grade on a test, student's performance is assessed on several different skills, and individual feedback is given on each topic. This is best demonstrated as the scoring system that many video games use (Dickson):

The goal of SBG is for students and the teacher to use this information to have a better understanding of what they know and what needs to be re-taught. This research was carried out in order to answer the following questions:

Angry Birds uses SBG by giving scores on each level, and allowing you to try to improve.

But what if it graded you like most schools do?

- **To what extent does the use of Standards Based Grading change students' sense of ownership of their grades and learning?**
- **To what extent do standards based grades measure students' achievement in an AP Calculus class?**

Investigation

SBG was used in two **Advanced Placement (AP) Calculus** classes for a full school year. The standards used in class were adapted from the College Board course description. **AP Calculus AB** is equivalent to the first semester of college calculus, while **AP Calculus BC** covers the second semester of college calculus. For most analysis, data from the two classes is combined. Each class had 10 students, although one student in AB calculus did not complete the AP Exam.

The content in the courses was broken down into a list of standards. Each quiz or test contained problems on several standards, and students received a score on each standard. When a standard was re-assessed, the scores were averaged. Students were asked twice if they were aware of their grades and in which topics they had their highest and lowest scores.

2015 AP Free Response Question #1

The rate at which rainwater flows into a drainpipe is modeled by the function R, where $R(t) = 20\sin\left(\frac{t^2}{35}\right)$ cubic feet per hour, t is measured in hours, and $0 \le t \le 8$. The pipe is partially blocked, allowing water to drain out the other end of the pipe at a rate modeled by $D(t) = -0.04t^3 + 0.4t^2 + 0.96t$ cubic feet per hour, for $0 \le t \le 8$. There are 30 cubic feet of water in the pipe at time $t = 0$.

(a) How many cubic feet of rainwater flow into the pipe during the 8-hour time interval $0 \le t \le 8$?

(b) Is the amount of water in the pipe increasing or decreasing at time $t = 3$ hours? Give a reason for your answer.

(c) At what time t, $0 \le t \le 8$, is the amount of water in the pipe at a minimum? Justify your answer.

(d) The pipe can hold 50 cubic feet of water before overflowing. For $t > 8$, water continues to flow into and out of the pipe at the given rates until the pipe begins to overflow. Write, but do not solve, an equation involving one or more integrals that gives the time w when the pipe will begin to overflow.

This question, from the AP exam, would be aligned to standards:
D9: I can interpret the derivative and integral in the context of rate of change problems.
D8: I can use equations and their graphs to recognize relationships between a function and its derivatives.
I2: I can find particular solutions and solve definite integrals.

There were some difficulties in implementing SBG in the classroom. The school-wide grade keeping software could not calculate the grades, and a different online system was used. Students had the ability to check their scores and grade at any time, but few did so.

Connection to Industry

In the workplace, training is an ongoing process. It is understood that individuals will learn some skills more quickly than others. Trainees are expected to make decisions about their own abilities and how to improve their skills. The use of SBG in high school encourages students to be self-reflective in their learning. Just as employees are expected to maintain their skills and use them after training, students are re-assessed on all standards throughout the year. Standards Based Grading teaches students an ethic of self-improvement, a trait that is in great demand in the workforce. (Tognolini & Stanley).

Findings

Students were not aware of their grades in class nor of their abilities. Overall, students' self assessments were close to their actual performance on only 5 out of the 24 standards. Many students never looked at their ratings on different standards, concerning themselves only with their overall letter grade. Out of the 20 students studied, only 5 were able to reliably predict their performance on a practice AP test.

Students' awareness of their SBG scores was not highly predictive of their results on the AP exam. Some students who were unaware of their scores did very well on the test, others did poorly. The students who were most aware of their SBG grades did poorly on the exam. These students had consistently struggled to earn the A that they wanted in class, and were more aware of their grades than the students who were doing well. Overall there was moderate negative correlation between awareness and their scores(r = -.59).

Student's Awareness of Grades vs. AP Exam Score

4th Quarter SBG Grades vs. AP Exam Score
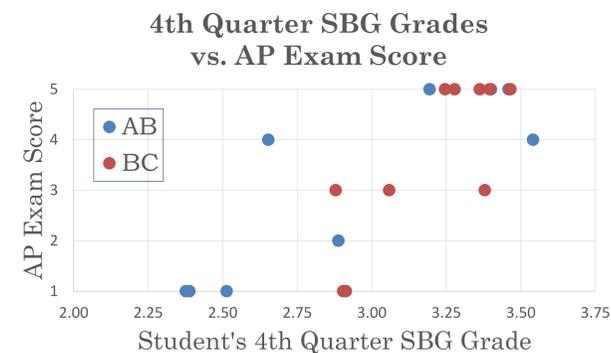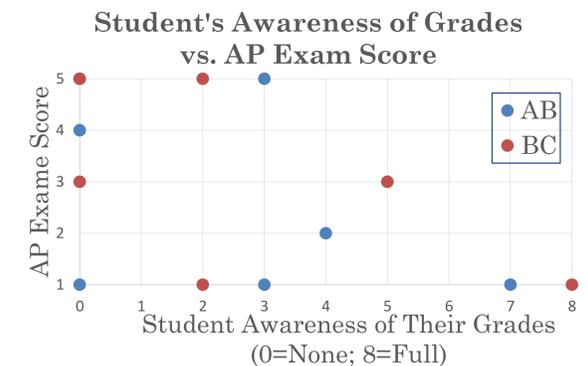
Students' 4th quarter grades were predictive of their AP Exam score. A regression predicting students' AP scores showed that about 60% of the variability (r^2 = .63) in students' AP exam scores were explained by their in-class grades. This shows a strong relationship between grades given in my class using standards based grading and their final outcome on the AP exam.

Implications

The use of SBG did not lead to improved student awareness of their abilities and learning. This could be due to difficulties students had in accessing their scores on a regular basis. The grading scheme did, however strongly predict student performance on the AP Exam. When my school uses a grade keeping program that accommodates SBG, I will use it and recommend others do so. In the meantime, I will make sure that students are as aware as possible of what they are expected to know and how well they are meeting those expectations. It is my goal to give students all the tools possible to take ownership of their learning, be aware of their abilities and shortcomings, and take steps to improve their performance in class. These skills, taught in high school, should help them to succeed in the workplace and in other areas of life.

References

Dickson, Bowman. (2009, Sept 7). What if Angry Birds Didn't Grade with SBG? Retrieved from: http://bowmandickson.com/2011/09/07/what-if-angry-birds-didnt-grade-with-sbg/

Tognolini, J., & Stanley, G. (2007). Standards-based assessment: a tool and means to the development of human capital and capacity building in education. Australian Journal of Education, 2, 129-145.

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