AC 2011-143: REWARDING LEVELS OF KNOWLEDGE IN GRADUATE STUDENT EXAMS

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REWARDING LEVELS OF KNOWLEDGE IN GRADUATE STUDENT EXAMS

Abstract

The objective of this paper is to develop a method for appropriately rewarding various levels of knowledge in graduate student exams. A graduate course in transportation was offered in the spring semester of 2003; this class was used as the control group. It was taught in the traditional lecture formant for eleven students. The average grade for this class was 67%.

In Fall 2009 an experimental group was taught using the method of rewarding various levels of knowledge. During the final exam students were allowed to request hints on how to solve the problems; they were not given answers but merely hints on how to obtain the answers. Each hint had a price, deduction of points from the final grade. The price of the hints exponentially increased as the number of hints increased. This discouraged students from coming to the examination unprepared and relying on the hints from the instructors. The policy was announced and explained well in advance to all the students.

The experimental method demonstrated a 13.2% improvement on the average grade of the class over the traditional grading method. The result was statistically significant. An exponentially decreasing relationship was demonstrated between the number of students asking hints and number of hints asked as the students proceeded through the steps of the problem. The authors plan to use this strategy in three other courses over the next three years. The method presented in this study may be used at other institutions with appropriate modifications in order to encourage students by rewarding their fund of knowledge.

Introduction

Becoming a graduate student requires a significant amount of hard work. There are many rewards for this work; seeking the highest grades, seeking effective research and internship programs, developing time management skills, seeking mentors, developing communication and writing (especially proposal writing) skills, discussing expectation of faculty, and involvement in study groups. However, there are a few formal methods for receiving encouragement and affirmation from faculty and none that reward levels of knowledge.

Confucius said, "Tell me, and I will forget. Show me, and I may remember. Involve me, and I will understand." Showing, demonstrating and involving require, among other things, time, lab facilities and money, making lecture the method of choice in many classes. Unfortunately the traditional lecture method does not incorporate the last two parts of Confucius' saying resulting in many students who do not understand the material presented in class. They receive low scores on their exams and become discouraged.

The authors began looking for ways to encourage students who were struggling to succeed. They noticed that some students were not able to obtain the correct answer to a problem because they made an incorrect calculation or did not understand the first step. Subsequent steps and concepts were correct but incorrect calculations in one step resulted in a failing grade. By breaking a

problem into steps and concepts and rewarding success at each step, students were encouraged to complete a problem and ask for help if they did not remember an abstract concept or equation. This paper describes a method for rewarding students for levels of knowledge during the final examination of a transportation engineering course.

Kolb's learning style theory ¹ identifies four types of learning styles: (1) Concrete Experience (feeling), (2) Active experimentation (doing), (3) Reflective Observation (watching), and (4) Abstract Conceptualization (thinking). While every student has some component of each of these four learning styles, there is usually one style that is dominant. In traditional lecture classes students with the first three styles might find it more difficult to learn since they are not provided with the experiences they need to master the material. Since it is difficult for them to understand, memorize, recall and meaningfully apply abstract concepts and formulas they will also have problems with examinations. In an unbiased population each learning style is equally represented. If we project that 25% of the population fall in each learning style, approximately 75% of the class will have problems mastering material that is presented in a lecture format.

This becomes obvious when looking at test results. Few students have full mastery of the concepts and, therefore, few score 100% on the examinations, especially final exams. Many students, however, have partial mastery of the material but do not receive credit for their fund of knowledge. For example, in a complex problem making a mistake or missing the first part of a system of equations results in an incorrect answer. Yet the first step often has less conceptual weight than the latter steps. The entire problem is scored incorrect even though the student might understand and be able to successfully complete most of the steps. The student is penalized as if he or she has no knowledge when, in fact, he or she might have an extensive fund of knowledge. The student receives a poor grade and becomes discouraged. The authors are motivated to encourage such students.

The rigor of the paper is established in two ways. A significant portion of faculty in engineering, technology and science colleges give only one half of the credit to students who provide numerically wrong answers even though their procedures are complete and correct. There are many instances where complex semi-empirical equations are needed at the beginning of the solution. From the experience of the instructor, the majority of graduate students (taking courses containing several semi-empirical equations) could not obtain correct answers in closed book examinations.

The National Council of Examiners For Engineering and Surveying (NCEES) follows the above philosophy (penalizing students heavily who go do not provide right answers even though they follow/demonstrate the correct and complete procedure) in grading the answers on the Professional licensure examinations. Even though the Licensure examinations are open book, there is little time for the number crunching and verification of the answers.

In both cases approximately one half of the credit is earned by the students. The authors believe in the philosophy that an opportunity for earning partial credit should be provided to students who know the concepts very well but make insignificant numerical mistakes at the beginning of a problem containing difficult semi-empirical equations in closed book examinations.

The objective

The objective of this paper is to develop a method for appropriately rewarding various levels of knowledge in graduate student exams.

Literature Review

No literature review exists on this topic. The authors have used their own experience in writing this paper.

Methodology

A graduate course in transportation was offered in the spring semester of 2003; this class was used as the control group. It was taught in the traditional lecture formant for eleven students. The average grade for this class was 67%.

In Fall 2009 an experimental group was taught using the method for rewarding various levels of knowledge. During the final exam students were allowed to request hints on how to solve the problems; they were not given answers but merely hints on how to obtain the answers. Each hint had a price, deduction of points from the final grade. The price of the hints exponentially increased as the number of hints increased. This discouraged students from coming to the examination unprepared and relying on the hints from the instructors. The policy was announced and explained well in advance to all the students.

The following two examples are used to further explain the methodology. Problem 1 deals with a transportation company's selection of an option for transporting coal slurry. Problem 2 asks students to rank various aircrafts with respect to decreasing accident risk. Problem 1 and 2^2 with their solutions are shown in Appendix 1.

Problem 1

The solution is organized into 6 parts: 1) Determination of initial cost, 2) Determination of operating cost (first six years), 3) Determination of operating cost (last four years), 4) Determination of revenue (first six years). 5) Determination of revenue (last four years), and 6) Choosing of option (last four years).

The first time a student asked for a hint it cost the student 5% of the total points for that problem. The price for additional hints was exponentially higher as shown in Fig 1. For example, two hints cost 20% five hints cost 75%. The instructor provided the students with the help they needed to solve the problems and at the same time discouraged them from asking more hints by exponentially increasing the points deducted for subsequent hints.

Problem 2

The solution is organized into five parts: 1) Determination of number of passengers, 2) Determination of trip length, 3) Determination of passenger-kilometers, 4) Determination of total

flight for one billion passenger-kilometers, and 5) Determination of risk units and relative ranking in terms of risk %.

The first hint on any of these issues cost the student 3% of the total points of the problem. The price of further hints was exponentially higher as shown in Fig. 2. For example, two hints cost 8% four hints cost 60%.

Results and Discussion

For Problem 1, the influence of number of hints asked by a student (and hints received from the instructor) on the cost of the grade is shown in Figure 1. The influence is exponential with power 2. The corresponding R^2 value is 0.99. The influence is quantified by the following equation ³⁻⁵.

 $Y = 1.25 X^2 + 10.1 X - 5.8$ (1)

For Problem 2, the influence of number of hints asked on the cost of the grade is shown in Figure 2. Here also, the influence is exponential with power 2. The corresponding R^2 value is 0.99. The influence is quantified by the following equation.

$$Y = 5.86 X^2 - 10.54 X + 7$$
 (2)

Performance of the control group was compared with that of the experimental group. The average grade of the control group was 68%, where the experimental group scored 77%. The experimental group showed 13.2% improvement over the control group. The t-test confirmed statistical improvement at a significant confidence level with an alpha value of 0.05.

Figs. 3 and 4 show an exponentially decreasing relationship between the number of students asking hints and number of hints asked as the students proceeded through the steps of the problem.

Since the process is a relatively complex one for faculty, the strategy is recommended to only those faculty who have time. The authors note that exams are not the only appropriate method for measuring graduate students progress. There are other suitable methods (e.g., oral presentations, assignments, quizzes, class participation, and discussions with the instructor outside the class) for measuring graduate students' performance. These methods demand even more time and energy from the instructor in order to apply the strategy of the study. The approach is not subjective because Figures 1 and 2 explain the exact amount of grade deducted for each hint given.

The authors acknowledge that the number of students who participated in this study is small. Subsequent studies will include more students.

Acknowledgement

The present work is a thorough expansion of Dr, Li Bai's unpublished presentation on "Penalizing Students for Obtaining Help During an Examination", made at the College of Engineering Assembly meeting.

Conclusions

(1) The experimental method demonstrated a 13.2% improvement on the average grade of the class over the traditional grading method. The result was statistically significant.

(2) An exponentially decreasing relationship was demonstrated between the number of students asking hints and number of hints asked as the students proceeded through the steps of the problem.

(3) The authors plan to use this strategy in three other courses over the next three years. The method presented in this study may be used at other institutions with appropriate modifications in order to encourage students by rewarding their levels of knowledge.

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Appendix 1

Problem 1

Coal distributors Corporation (CDC) is considering adding one coal slurry pipeline between their main facility and location L. The length of the line is 250 km. The cost of placing a pipeline varies by size:

Gathering line: 275,000 per km (throughput: 120 l/s)

Trunk line: 375,000 per km (throughput 380 l/s)

A third option of CDC is to lease trucks at a cost of \$1.25/km at a full tr4uck load. One truckload is equivalent to a throughput of 60 l/s; (liter per second). Only full truck load shipments will be made.

The demand for the first 6 years is estimated at 165 l/s; it is expected to drop to 90 l/s after that point and to diminish after another 4 years. The operating cost is 2.5 Cents/l (per liter) and 1.75 cent/l for the trunk and the gathering pipeline, respectively; and if CDC charges a flat rate of 3.25 cents/l, which option should CDC choose? (Round all monetary estimations to the closest million).

Example 2

The risk of an accident during a commercial airline flight may be assumed as follows: 39% during takeoff and climb, 4% during cruise, 53% during decent, approach, and landing. The remaining % risk is during loading, unloading, and taxiing; this component should be ignored in this exercise.

Considering the commercial jet aircraft data supplied here, and assuming that on average 86% of the seating capacity is utilized and that the average trip is three-fourths of the maximum range, calculate the risk factor for each aircraft for every one billion passenger-km. Rank the aircrafts in decreasing risk factors. Determine how many times each aircraft is riskier compared to the aircraft with the lowest risk.

Aircraft	Passenger	Maximum	Takeoff, climb	Decent, approach
	Capacity	range (km)	distance (km)	land distance (km)
DC-10	275	8200	120	77
B-747	420	9400	130	85
B-737	95	1600	55	48
A-310	260	2500	65	55

SOLUTION TO PROBLEM 1. ひ DIST. = 250 km Gathering pypeline - \$ 275,000/km cost \otimes operating cost = 1.75 \$/1 charging hate = 3.25 \$/1 Initial cost = 275000x 250 - \$68750000 operating cost = 6 x 365 x 24 x 3600 x 120 x 0.0175 + 4 × 365 × 24 × 3600 × 90 × 0.0175 = 397353600 + 198676800 = \$ 596030400 3.25 (6×365×24×3600×120) 100 + (4×365×24×3600×120) Revenu = 1106913600 Profit = 1106913600 - (68,750000 + 596030400) 442133200 = \$442 million -Towerde pypelini - \$ 375 000/km wit 6) Throughput 3801/s operating cost = 2.5 \$/1, charging rate = 3.25 \$/1

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T tructiload 10 # of truch back = 4. 25136 × 10 60 egun 709560000 <u>س</u> Total cost. = 1.25 × 250 × 70 9560000 =\$221737500000 same as the trushe fini Revenue ----\$ 1383642000 Deducting we get a loss of millions leaving the bruches by Merefore using a gathering pypeline is much nove profitable Kan any other option υ

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SOLUTION TO PROBLEM 2

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