EFFECTIVE LEARNING IN LARGE CLASSES THROUGH RISK MANAGEMENT

Josef M. Broder, Bernard V. Tew, and Jeffery R. Williams

Abstract

Risk Management strategies for maintaining student performance in large classes are discussed. Risk management theory is discussed and used to describe student behavior. Results of risk management experiments in which students are exposed to alternative levels of grading are reported along with other factors which influence student behavior. Class performance was not found to decline under a system involving only a 50 percent chance of assignments being graded. Procedures for implementing and limitations of chance grading systems in large classes are discussed.

Key words: resident instruction, risk management, student evaluation, student performance.

Undergraduate agricultural economics programs have experienced unprecedented growth in enrollment during the past decade (Beck et al.). In many departments, the increase in enrollment has been accompanied by increases in class size and a need for instructors to modify teaching techniques and classroom procedures to accommodate the large class format.[1] The transition from small to large class instruction is not without frustrations. Teachers are reluctant to delete course assignments which provide valuable individualized learning opportunities. However, certain kinds of assignments tend to be so labor intensive for the instructor that they are prohibitive for large classes.

This paper addresses the problems associated with both teaching and learning in large undergraduate agricultural economics classes. Strategies for more effective teaching and learning in large classes through risk management are discussed. More specifically, the objectives of this paper are to: (1) develop a risk management framework for analyzing student behavior and performance in the classroom, (2) examine student behavior and performance under alternative risk situations, and (3) offer suggestions for more effective learning through risk management.

ENROLLMENT TRENDS

From the period 1970 to 1980, average enrollment in undergraduate agricultural economics departments in the southern region increased approximately 210 percent as compared to a 206 percent increase for the United States and Canada (Beck et al.). Approximately three-fourths of this growth occurred from 1975 to 1980.

Increases in the number of agricultural economics majors and the number of nonmajors enrolled in agricultural economics courses have largely contributed to increases in the size of agricultural economics classes. The most recent available data on class size in agricultural economics departments indicated that the average class size in the southern region was approximately 41 at the undergraduate level, 15 at the dual graduate/undergraduate level, and 8 at the graduate level (Broder, 1981). While there is some disagreement as to the definition of a large class, researchers in economic education have generally defined class sizes of 30 or less as being small and 30 and greater as being large classes (Levin; Gage; Mirus; Lewis and Dahl). According to this generally accepted definition of a large class, data indicate that the large class now dominates many undergraduate programs in agricultural economics.

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[1]Since these data were collected, total enrollments in colleges of agriculture and enrollments in some departments of agricultural economics have declined (NASULGC). Despite these declines, large classes continue to dominate many undergraduate programs in agricultural economics.

TEACHING AND RISK MANAGEMENT

Teaching of risk management in agricultural economics courses has been done through farm management games (Menz and Longworth; Boehlje et al.), grain merchandising and feed supply management games (Babb and Eisgruber) and through estimation and use of personal probabilities in decisionmaking (Nelson and Harris). In general, these approaches have simulated various agriculturally related decision processes. In contrast to previous applications which have concentrated on the subject of risk management, this paper will make risk management applications to the actual delivery of a course. Hence, the risk management strategies discussed herein are not limited to management courses.

The theoretical framework used to analyze the classroom learning process is thought to be similar to that used to analyze farm management decisions. The risk management framework discussed by Penson and Lins can be used to construct a parallel between farm management decisions and student behavior. Farm managers allocate scarce resources among competing enterprises and activities while students allocate scarce personal and financial resources among alternative courses and activities (clubs, work, family, etc.). Farm managers attempt to maximize some objective function (profits and/or utility) while students attempt to maximize their particular objective function (future earnings and/or utility). Decisions made by students may be as broad as choosing a college or major or as narrow as deciding how long to study for a particular examination.

When working toward specific objectives, students operate under conditions of risk and uncertainty. Students are expected to learn subject matter and perform on examinations and other assignments. Students do not operate in situations of perfect knowledge; that is, they must make estimates of resources needed to achieve a particular grade in a course. Whether this lack of perfect knowledge creates situations of risk or uncertainty depends partially upon whether the student is familiar with the subject matter of the course. Seasoned students are assumed to encounter situations of risk in which they are able to attach subjective probability estimates on how well their efforts will contribute toward course objectives.

Penson and Lins described two sources of risk which can be applied to student behavior. Technical risk which results from errors in forecasting production yields or objectives is comparable to risk from errors in estimating the production relationship between student effort and learning. Market risk which results from errors in forecasting market prices is comparable to risk from errors in predicting how the class as a whole will perform and, subsequently, what relative grade value will be given to an individual's performance.

In farm management, risk management reflects the variability of cash revenue flows. For students, risk measurement should reflect the variability in test scores and ultimately, course grades. For example, students can estimate a grade for a particular course, i.e., in a discrete outcome case, as follows:

$$(1) \quad E(x_j) = \sum_{g=1}^{G} X_{jg} P_g,$$

where: $E(x_j)$ = estimated course grade,
X_{jg} = specific course grade, and
P_g = probability of achieving specific a course grade.

Expected course grades in all courses taken during a quarter can be combined to estimate a quarterly grade point average (GPA) as follows:

$$(2) \quad E(GPA) = \sum_{j=1}^{n} E(X_j)\, C_j \div \sum_{j=1}^{n} C_j$$

where: $E(GPA)$ = estimated grade point average and
C_j = credit hours for the specific course.

Since the expected quarterly GPA is based on probability estimates, the likelihood of a specific GPA depends on the standard deviation of the expected GPA. The standard deviation of a probability distribution can be estimated as follows:

$$(3) \quad \hat{\sigma} = [P_1\,(X_1 - \bar{X}_1)^2 + \ldots + P_n\,(X_n - \bar{X}_n)^2]^{1/2}$$

where: $\hat{\sigma}$ = estimated standard deviation,
P = probability estimate, and
X = estimated course grade.

The larger the estimated standard deviation, the more grade risk associated with a particular course program. The level of grade risk faced by a particular student is thought to be a function of the student's willingness and ability to accept risk.

RISK EXPERIMENT

The conceptual framework was used to design a classroom experiment in which students were exposed to various levels of risk. Objectives of the experiment were to determine how various levels of grade risk affect student behavior and performance and to suggest how risk management might be used to improve learning in large classrooms. In the context of this study, the concept of risk management is used to describe the systematic use of teaching techniques whereby the instructor exposes students to risk to enhance the learning process.

DATA

Data for the risk experiment were obtained for: (1) two separate environmental economics classes at the University of Georgia, (2) two separate sections of an economics course at Colorado State University, and (3) a resource economics course at Kansas State University. Replication of the experiment across courses, instructors, and universities was done to strengthen the validity of the results. Students in these classes were given weekly or bi-weekly quizzes for the duration of the quarter/term. Both in-class and take-home quizzes were used in the experiment. The quiz component of the final course grade ranged from 20 percent at Kansas State University to 70 percent at Colorado State University. The balance of the course grade was based on major examinations and term projects. This grading format was particularly suited for the experiment because it enabled the instructor to monitor student performances on a frequent and continuous basis.

METHOLOGY

To establish a baseline for each student, all quizzes in each of these classes were graded and recorded during the first half of the quarter/term. At midterm, the classes or sections were divided into control and experimental groups and a system of chance or risk grading was implemented according to one of the following experimental designs.

Design I. One-half of the class was randomly designated as the control group and had all of their post-midterm quizzes graded and recorded as before. The other half of the class served as the experimental group and faced a 50 percent probability that a given post-midterm quiz would be graded and recorded. This design was used in the Kansas State and University of Georgia (1980) experiments. Quizzes given at Kansas State were of the take-home variety while all quizzes at Georgia were taken during class.

Design II. At Colorado State University, two sections of the same course were taught by the same instructor at different times of the day. At midterm, one of the sections was randomly selected as the control group and had all of their post-midterm quizzes graded and recorded as before. The other section served as the experimental group and faced a 50 percent probability that a given post-midterm quiz would be graded and recorded. Both in-class and take-home quizzes were used at Colorado State.

Design III. At midterm, the class was randomly divided into four groups with one control and three experimental groups. The control group had all their post-midterm quizzes graded and recorded as before. Experimental groups faced either a 66.7, 50.0, or 33.3 percent probability that a given post-midterm quiz would be graded and recorded. This design was used at the University of Georgia (1981) and included all in-class quizzes.

Knowledge of the experiment and group selection was not shared with the students until the experiment was initiated. After the experiment was initiated, students were only aware of the probabilities that their grade would be recorded when taking the weekly or bi-weekly quizzes. During the experiment period, all quizzes were graded but only those indicated by a die-toss were recorded as official grades. A die was tossed for each student in the experimental groups for each post-midterm quiz. For example, if a four, five, or six was rolled on the die, the quiz grade was recorded for students with assigned probabilities of 50 percent. If a five or six was rolled, the quiz grade was recorded for students with assigned probabilities of 33 percent. If a three, four, five, or six were rolled, the quiz grade was recorded for students with assigned probabilities of 67 percent. If these numbers were not rolled for the students in their respective groups, their quiz grade would not be officially recorded. Results of each die toss and quiz grades were made known to students during the experimental period.

At the end of the experimental period, individual student quiz scores were examined to determine if student performance had declined under alternative risk situations.[2] Following Campbell, regression discontinuity analysis (RDA) was employed to test for changes in student performance.[3] In contrast to simple comparisons of mean grades before and after the experiment, RDA takes into account trends which may have occurred in the absence of the experiment. Likewise, post-midterm changes in grade variance alone may not provide sufficient evidence of a decline in performance when mean grades do not decline.

The RDA model shown in Figure 1 can be estimated using binary variables to test for intercept differences (Kmenta, p. 419). Trends in quiz grades were estimated using the following equation:

$$(4) \qquad Y_i = B_o + B_1C_1 + B_2E_i + e_i$$

where: Y_i = average grade of experimental group for the i^{th} quiz,
C_i = average grade of control group for the i^{th} quiz,
E_i = intercept binary = 0 if quiz occurred before experiment; and 1 if during experiment, and
e_i = error term.

In essence, this model contrasts the performance of experimental student groups with that of the control student group and tests if a significant decline in performance occurs with the experiment. Campbell and Stanley argue that only abrupt changes in performance at the onset of the experiment are considered valid evidence that the performance decline was influenced by the experiment. Gradual declines in performance which occur during the experiment are not accepted as sufficient evidence that the performance decline was due to the experiment. They argue that such gradual declines in performance may be due to the effects of student history or maturation (p. 5).

RESULTS

Equation (4) was used to make regression discontinuity estimates of changes in performance under alternative systems of risk grading, Table 1. The strong statistical significance associated with the control group variable (C_i) indicated that this variable was a highly significant estimator for experimental group performance. Results indicate that no statistically significant declines in student performance were found for experiment groups facing 50 or 67 percent probabilities that a post mid-term quiz would be recorded. The negative values associated with the control group variable indicated that there had been some decline in performance at the onset of the experiment. However, these declines were less than that required for conventional levels of statistical significance.

When the grading probability was reduced to 33 percent, there appeared to be a significant decline in student performance at the onset of the experiment. A comparison of group performances indicates that in four independent trials, students maintained the same level of performance even when there

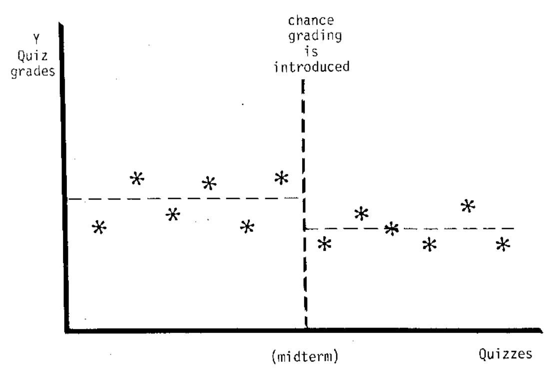

Figure 1. Regression discontinuity model for measuring performance deadlines in chance grading experiment.

[2]Regression discontinuity analysis (RDA) was applied to measure student response to alternative levels of risk. When compared to measures of overall variance in quiz grades, RDA is a more appropriate indicator of risk as defined by the variance (decline) in student performance at the onset of the experiment.

[3]RDA is one of several experimental and quasi-experimental designs which have been developed by educational psychologists for verifying educational improvements. For a further explanation, see Campbell and Stanley.

TABLE 1. REGRESSION DISCONTINUITY ANALYSIS FOR CHANGES IN STUDENT PERFORMANCE UNDER ALTERNATIVE SYSTEMS OF CHANCE GRADING BY INSTITUTION AND TERM

Institution and term	Number of students		Number of quizzes	Quizzes as % of final grade	Chance grading probability	Estimated coefficients			
	Experimental	Control				Intercept	Control group scores	Intercept binary	R^2
Georgia:									
Fall-1980	23	25	14	30	0.50	0.820 (0.490)[a]	0.007[d] (0.002)	−0.090 (0.100)	0.68
Fall-1981	9	12	15	30	0.67	0.450 (0.480)	0.009[d] (0.002)	−0.100 (0.140)	0.74
Fall-1981	12	12	15	30	0.50	1.970[d] (0.330)	0.004[d] (0.001)	−0.100 (0.090)	0.61
Fall-1981	13	12	15	30	0.33	1.550[d] (0.490)	0.005[d] (0.002)	−0.560[d] (0.150)	0.70
Colorado State:									
Fall-1984	12	17	16	70	0.50	0.840[b] (0.434)	0.008[d] (0.002)	−0.084 (0.396)	0.70
Kansas State:									
Fall-1984	10	10	12	20	0.50	5.801[d] (1.109)	0.004[c] (0.001)	−0.449 (0.364)	0.49

[a] Standard errors are shown in parentheses. [b] Significant at the alpha = 0.10 level. [c] Significant at the alpha = 0.05 level. [d] Significant at the alpha = 0.01 level.

was only a 50 percent chance that a particular quiz would be graded and recorded.[4] However, chance grading systems with probabilities of less than 50 percent may lead to declines in student performance.

This study found evidence that student performance may not decline with a system of chance or risk grading. This suggests that merely the risk of receiving a particular grade may provide the necessary incentive for learning. Although preliminary, these findings have certain implications for effective learning in large classes. Practical implications and limitations of the study will now be addressed along with suggestions for further study.

Quantity of Assignments

Instructors are reluctant to make frequent assignments in large classes because of the lack of resources to adequately supervise and evaluate these assignments. Frequent class assignments facilitate student participation, repetition of material, and student-teacher interaction, all of which are essential for learning. A system of risk grading could allow the instructor to make more class assignments and still maintain an effective level of interaction with students on assignments. With a system of risk grading, the number of assignments may be increased without a decline in student performance or a proportionate increase in teaching resources.

Quality of Assignments

When assignments are made in large classes, instructors are more apt to use "objective" or short answer exercises instead of "subjective" or essay assignments. While both types of assignments contribute to learning, heavy reliance on objective exercises encourages positive learning and/or memorization. When designed and evaluated accordingly, written assignments require students to actively analyze, synthesize, and restate concepts and ideas. Knowledge gained through active learning, such as writing, tends to be more enduring. Likewise, writing skills can be valuable in the student's career. Again, with a system of risk grading, the instructor may be able to increase the number of essay or written assignments without a proportionate increase in teaching resources.

Student-Teacher Interaction

Effective learning requires frequent interaction between students and teachers. With conventional systems of student evaluation, feedback is limited to assignments which can be graded by the instructor. Of course, the instructor can make numerous non-credit assignments, but students generally take these less seriously and work less diligently on assignments with no potential for reward or punishment. Also lacking with non-credit assignments is the feedback associated with the evaluation process.

[4]The reader is reminded that equation (4) is a model explaining averages and not a model explaining the performance of individual students. A model for individual students (non-grouped data) would more appropriately be estimated using generalized least squares.

Under risk grading, alternative methods of providing student feedback can be used. First, when assignments are short and frequent, a system of posting preferred answers to assignments may be useful for students whose assignments are not selected for grading. For many, the availability of these preferred answers reduces further direct interaction with the teacher. The credibility of these preferred answers can be enhanced by anonymously posting actual answers of superior students whose answers were officially graded.

Second, when a higher level of interaction is needed, an expanded role for graduate teaching assistants can be developed. Graduate teaching assistants have the enthusiasm but often lack experience in evaluating the assignments of undergraduates. For this reason, there is often some dissatisfaction among students, faculty, and administrators when graduate teaching assistants are used to assign grades (Siegfried and Fels). Risk grading would utilize graduate teaching assistants to evaluate assignments which are not officially recorded and provide students with a more direct form of feedback. Graduate teaching assistants could gain experience in evaluation without some of the political repercussions.

Limitations

This study has reported findings and implications of using risk management strategies in large classes. Findings of the study are preliminary and represent an initial research effort on this subject. The practical implications of risk management for teaching are promising and merit further study. A brief discussion of study limitations is needed to place these findings in perspective and to guide future research.

Future studies should take into consideration and control for factors which could not be controlled due to the experimental nature of this study. For example, this study did not test for differences in student behavior and performances under alternative methods of feedback. If student responses to evaluations by graduate teaching assistants differ from those received from faculty, results of the experiment may be altered by use of graduate teaching assistants.

Future research should take into consideration certain structural and personal factors which influence student behavior and performance. Student response to risk situations is influenced by the student's willingness and ability to accept risk. Several of these factors were identified in the study but data limitations precluded a rigorous analysis of these factors. Among these were student personality and attitudes toward risk and student ability to accept risk. Important in the latter category are the student's cumulative grade point average, class standing (credit hours completed) and course load taken during the quarter, work load, etc. Future research should examine the extent to which these factors might influence the student's risk management strategy. For example, would sophomores respond differently than seniors to a particular risk management strategy?

A potential limitation and area for further investigation involves student attitudes toward risk management. While student attitudes toward the experiment were generally positive, some students may view this approach as being arbitrary and inequitable. This potential for negative student reaction may be reduced by: (1) adjusting the portion of the student's grade derived from risk grading, (2) adjusting the number of exercises for the risk grading system, and (3) using graduate teaching assistants to provide supplemental feedback. The second requirement would be needed to avoid small sample biases in grading.

CONCLUSIONS

The major elements of this paper were: (1) large classes have become the norm in many undergraduate agricultural economics programs, (2) student behavior and performance in the classroom can be described in the context of risk management, and (3) instructors can introduce alternative risk management strategies to influence student behavior and performance.

This study found evidence that student performance may not decline with a system of risk or selective grading. This suggests that merely the risk of receiving a particular grade may provide the necessary incentives for learning. With a system of risk grading, instructors can enhance the effectiveness of their limited teaching resources. Additional assignments can be introduced into large classes, assignments which would be prohibitive without such a labor saving system. In particular, some of the individualized written exercises which are highly effective in small classes may also be incorporated into larger classes.

Findings of this research are preliminary and further research is needed to substantiate the advantages and limitations of using risk management in the classroom. Since the pros and cons of risk management are likely to differ among students, courses, and instructors, careful pretesting is recommended before fully implementing a particular system. The risk management system for a particular class should be evaluated on the basis of: (1) the impacts on student motivation and learning, (2) the system's fairness to students within, between, and among classes, and (3) the efficiency gains in teaching resources.

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