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Abstract

This chapter examines the motivational impact of resurrection points; a systematic method for encouraging students to earn back missed points on semester exams through performance on the final exam. This method for utilizing hour exams as a type of formative assessment was explored for three courses across three years. Four of the nine individual courses sampled offered resurrection points. A student's grade trajectory based on semester exam performance was used to predict how well a student needed to perform on the final exam to receive a particular course grade. The need to over or under perform based on semester performance was then compared to whether the student actually earned that letter grade. Odds ratios suggest that students in resurrection point courses were more likely to earn a particular course letter grade if they needed to perform better on the final than they had on semester exams. This observation is consistent with an explanation of student behavior during final exams that effort in various courses is rationed based on the perceived value of the exam within the course it is administered.

Disciplines

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Chapter 7

Exploring the Apparent Motivational Impact of Resurrection Points from Final Exam Performance

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This chapter examines the motivational impact of resurrection points; a systematic method for encouraging students to earn back missed points on semester exams through performance on the final exam. This method for utilizing hour exams as a type of formative assessment was explored for three courses across three years. Four of the nine individual courses sampled offered resurrection points. A student's grade trajectory based on semester exam performance was used to predict how well a student needed to perform on the final exam to receive a particular course grade. The need to over or under perform based on semester performance was then compared to whether the student actually earned that letter grade. Odds ratios suggest that students in resurrection point courses were more likely to earn a particular course letter grade if they needed to perform better on the final than they had on semester exams. This observation is consistent with an explanation of student behavior during final exams that effort in various courses is rationed based on the perceived value of the exam within the course it is administered.

Instructors are inclined to hope that students prepare equally and at their best level for every exam. Most students are taking more than one course and are continuously making effort decisions about their courses and coursework. This type of learning has been labeled strategic (*1*) and can be contrasted with categories of "deep" or "surface" learning (*2, 3*). To the extent that students use strategic approaches in learning, trade-offs in study time are particularly common during final exam periods when students encounter several, often high-stakes, tests. In some sense, for most students, and for those using strategic learning methods in particular, study time is apportioned by the student. Within this premise, the question becomes: Are there ways to garner more student attention during final exams?

This question is important because accurate assessments of learning can be confounded when the extent of student effort can skew measurements. A student who chooses to exert less effort to prepare for an exam in one course in order to save study time for another course affects the measurement in both courses. As a result, a well-constructed test may reflect what the student knows and is able to do at the time of the examination, while at the same time not accurately reflecting the student's overall ability or proficiency in the material. Nonetheless, the final exam represents the last opportunity for a student to demonstration understanding, so any chance to further learning in the course is arguably done at that point. It has been argued that some students easily pick up the deficient material when it becomes essential to their success in later courses such as physical chemistry (*4*). Still, it seems helpful to use every opportunity to help students learn, particularly material that they have found challenging during the course. Providing additional motivation to study for the final exam carries importance, couched as it is in a choice environment where it competes, in the mind of the student, with demands from all the other courses they are taking that semester.

Defining the Concept of Resurrection Points

In Tobias and Raphael's book *The Hidden Curriculum*, Herschbach describes resurrection points as a method for increasing student motivation for learning or relearning material for the final exam (*5*). With this pedagogical technique, the student has the opportunity to earn a maximum score on the final examination as well as raise all previous examination scores to the maximum score. If the student earns a higher percentage score on a portion of the final exam than they did on the semester exam that covered the same material, then "resurrection" points are earned. The number of points earned is such that the lower score on the semester exam is essentially replaced by the higher score on the final exam. Practically speaking, the points can be readily calculated in a spreadsheet using the equation:

$$\text{Points} = \text{Max}\left(0, \left\lfloor\left(\frac{\text{Final}\%}{100}\right) \times (\text{Hour exam max}) - (\text{Hour exam score})\right\rfloor\right)$$

This calculation is repeated for all semester exams. A student, however, is not punished (i.e., a previous exam during the semester score is never lowered) for scoring lower on the given material on the final exam for a given semester exam than they did on the actual semester exam. As an example, consider a course with 3 (mid-term) hour exams each worth 100 points. Say a student scores 85 on exam 1, 68 on exam 2 and 76 on exam 3. The final exam has four sections, each worth 50 points. Section A corresponds to exam 1, B to exam 2, C to exam 3 and D tests material covered after the final hour exam. If the same student scored 41 on part A, 43 on part B and 39 on Part C the resulting resurrection points earned would be 20: 0 points for part A, 18 points for part B and 2 points for part C. Note that they do not receive negative points from part A even though their performance decreases relative to the relatively strong first exam. In terms of raw points, students only benefit from resurrection points. In this scheme, achieving a perfect score on the final exam is equivalent to achieving a perfect score on all semester examinations. The thought is that students will spend time addressing their learning deficiencies determined from their semester performance in preparation for the final examination. Moreover, if a student demonstrates proficiency at the end of the semester, then arguably the student has learned all the information and has earned a grade that reflects that learning.

The use of resurrection points can strike some instructors as unduly generous. It is possible for students to substantially increase a course grade. In over 20 years of implementation (by author TAH) in general chemistry courses the much more common level of grade impact is roughly 1/3 of a grade (e.g. from a B to a B+), and increases of two grades or more (e.g. from a C to an A) have occurred less than a dozen times for students who are replacing actual hour exam performances. Resurrection points also provide a convenient way to manage make-up exams. Excused hour exam absences can be made up via the resurrection points alone. For years one of us (TAH) used both make-up exams and resurrection points for missed exams, but analysis of performances revealed that students obtained resurrection points in over 90% of the cases where make-up exams were given. In other words, even when make-up exams are provided, students who miss exams are often behind (because of illness, for example) in several classes and their performance is less than ideal for the make-up. Using resurrection points alone for make-up exams is not only logistically facile for the instructor, it tends to ease stress for the student returning from an illness by requiring no make-up exam in one of their courses.

For these reasons, the resurrection points concept is potentially an important learning tool. At least in principle, it may provide added motivation for students to study for the final examination and thereby enhance net learning in a course. One aspect of a course that generally motivates student learning is testing (*6*), so the confluence of customary test-oriented motivation factors and resurrection points may influence studying. If this premise is true there may be measurable ways, based on test performance that can adjudicate the role of resurrection points on student learning. Of course there are other aspects to courses that potentially influence motivation and in chemistry these include relevancy, applications, and current research projects (*7–9*).

Beyond chemistry education, the role of motivation in learning has received considerable attention. One organizational theory of motivation proposed initially by Deci and Ryan (*10*) and recently refined (*11*) places the locus of motivation along a continuum. Thus, student motivation may range from no motivation (amotivation) through varying levels of extrinsic motivation to fully intrinsic motivation. Individuals who lie at different spots along this continuum will tend to be activated by different stimuli. While it might be desirable to have every student in a large classroom with strong intrinsic motivation, the reality that such a class is encountered is rather unlikely. Accordingly, the possibility that a tactic such as resurrection points on the final exam can trigger the extrinsic motivation categories represents a possible mode of action for improved performance in a course. In terms of chemistry specifically, one study found (*12*), via self-report survey work, that motivation of students in general chemistry tends to lag as the semester progresses, a factor that, if true, would seem to predict lower achievement on final exams. Similar work applied to motivation in organic chemistry (*13*) found that students with stronger intrinsic motivation factors tended to perform better in the course. Student motivation remains a widely studied construct in educational psychology beyond test-taking factors. For example, several recent studies have sought to parse origins of motivation in terms of several factors *s*uch as self efficacy (*14*), epistemological beliefs (*15*),, extrovertedness, (*16*), and coping strategies (*17*). Student self-report motivation instruments have been devised (*18*) and validated (*19*) within science contexts. Studies that investigate the role of formative assessment on student motivation (*20*) and differences between on-line and classroom-based courses (*21*) have also been described recently.

Given the established importance of motivation in promoting student learning (*22*, *23*), the question of whether or not resurrection points can affect motivation becomes important. At least one study has found evidence that student perception of the value of a test influences motivation for the test (*24*). Therefore, a potential proxy for understanding motivational factors associated with resurrection points lies in differences in student final exam performances based on the availability of resurrection points. Despite this interest, the ability to devise a quasi-experimental study to investigate the role of resurrection point availability is limited. Teachers who use this method are generally convinced of its utility and thus offering an opportunity to earn resurrection points to some students and others not is an unethical proposition. Given this constraint, the best possible method would be to compare similar courses at a single institution where resurrection points have been used in different ways or not used at all. This is the approach reported here. Thus, we consider connected issues related to the hypothesized effect of resurrection points, based on available empirical data. First, does the availability of resurrection points result in observable differences in student performance on final exams in courses that use them relative to similar courses that do not? Second, does changing when students are aware of the availability of resurrection points influence observable student performances on final exams? This latter question seeks to provide at least preliminary information about whether students "game the system" more if they know about resurrection points from the outset of a course.

Comparisons between final exam performances of students who have the opportunity to earn resurrection points on their final exam with those who do not have such an opportunity can provide insight into how their availability affects student study habits. Ultimately, resurrection points are tied to students improving their performance at the time of the final exam, an effect that represents "over performance" at least relative to test results during the rest of the course. If resurrection points provide measurable motivation, those students with access to them will have a higher odds-ratio of over performing on the final exam to earn a higher grade than those students who do not have the opportunity to earn resurrection points on their final exam. This hypothesis can be tested using logistic regressions of whether a student earns a particular grade (yes or no, binary data) versus a measure of student performance during the semester. Logistic regression has been described in a number of previous articles including from our group (*25*). Essentially this method provides a way to quantify the difference between the "grade trajectory" of a student during the semester and the ultimate grade after the final exam. If courses with resurrection points behave differently than those without them, this result would be consistent with the hypothesis that this teaching technique increases student motivation. To this end, binary logistic regression odds-ratios were calculated and compared for general chemistry courses where resurrection points were implemented and for courses where no resurrection points were implemented. Additional factors, such as when in the semester students are aware of the availability of resurrection points (from the start or mid-term) and between and within specific general chemistry course types (i.e., one semester course for engineering majors or 1st semester of a yearlong course for STEM majors) are also considered in the analysis presented here.

Analysis Methodology and Summary Statistics

De-identified student performance records were obtained with Institutional Review Board approval for three general chemistry courses at Iowa State University across three academic years. One of these courses is a single-semester course for pre-engineering students that covers topics typically covered in both semesters of general chemistry and is titled "survey" throughout the presentation of data. The other two courses are the first- and second-semester of the traditional two-semester general chemistry course for science majors, and are labeled "1st Term", and "2nd Term" respectively throughout data presentation. Demographic data were not collected for the students in the study. Table 1 summarizes the nine courses by course type, data collection semester, number of students, notation of when resurrection points were announced to students, number of semester exams, number of points for the final exam, and the total points for the course. For all courses, points from non-examination sources were less than 40% of the total points; therefore, a significant portion of a student's grade was determined via semester and final exams.

Looking at the information in Table 1, it is clear that there are variations in how the courses were structured. While it is impossible to control for the potential variability associated with this feature of the courses, it is also important

to note that the analysis presented here has access to a large number of student performances. Roughly 1050 students studied had access to resurrection points that they knew about from the start of the course. Another ~1400 students had access to resurrection points, but were not aware of that fact until after the course drop deadline was passed. Finally, over 4400 students were from courses that did not offer resurrection points. This sample includes courses taught by several instructors, some of whom used resurrection points and some who do not.

Table 1. Summary of General Chemistry Courses Included in the Study

Course Type	Date of course	N	Resurrect Points	# of hour Exams	Final Pts. Avail	Total Pts. Avail
Survey	F 2010	746	Aware from Beginning	4	200	830
Survey	F 2011	908	Aware from Beginning	3	200	800
Survey	F 2012	955	Aware after Drop Date	3	200	800
1st Term	F 2010	902	(Not Awarded)	4	150	800
1st Term	F 2011	1,041	(Not Awarded)	4	150	700
1st Term	F 2012	1,155	(Not Awarded)	4	150	800
2nd Term	S 2011	641	(Not Awarded)	3	150	700
2nd Term	S 2012	697	(Not Awarded)	3	150	700
2nd Term	S 2013	774	Aware after Drop Date	3	150	700

The premise of this analysis is that students will use external motivational factors during finals to apportion their time resources for study. As such, the "payoff" to the student is whether or not a desired, higher grade is obtained. To the extent that this is a measurable goal, it is also inherently binary, either students do, or do not, achieve the higher grade – i.e., change their grade trajectory. To determine if there was a change in grade trajectory at the time of the final exam, for each student, the total number of points prior to the final examination was calculated; this value was utilized in determining how many points the student would then need to earn on the final exam to receive an A (90%), B (80%), C (70%), D (60%), or F (< 60%) for the course. Because the point value for the final

exam differed by course, an average percent needed on the final exam to receive a letter grade was calculated. (Remember, students in resurrection point courses could earn more than the available number of points on the final because they could earn the maximum point value of the final exam and any points missed on semester exams.) It was then determined which letter grades were possible for each student to earn by asking: were enough points available on the final exam for a student to receive that letter grade? For example, in courses that did not offer resurrection points, it was impossible for some students to earn enough points to receive an A or a B; in addition, it was possible for some students to receive 0 points on the final exam and not receive lower than a C for the course. Table 2 summarizes the number of students that could have possibly earned each letter grade in the courses studied. Note that for the engineering "survey" courses and the 2013 2nd STEM courses (i.e., resurrection point courses) that a rather large number of students (upwards of 90% of the students) could, in principle, earn an A or B letter grade compared to non-resurrection point courses (around 35% of the students); this observation is to be expected because resurrection point courses allow students to gain back points "lost" during semester exams and thereby present the possibility, if not the probability, that they can get top grades in the course regardless of prior test performance.

Table 2. Number of Student Able to Earn Each Final Letter Grade in the Courses Analyzed[a]

Course Type / Date	N	N able to earn "A"	N able to earn "B"	N able to earn "C"	N able to earn "D"
Survey / F10	746	717	494	239	73
Survey / F11	908	801	709	404	162
Survey / F12	955	894	627	281	101
1st Term / F10	902	371	528	319	126
1st Term / F11	1,041	653	552	310	114
1st Term / F12	1,155	529	614	418	199
2nd Term / S11	641	169	378	360	208
2nd Term / S12	697	320	408	312	140
2nd Term / S13	774	677	538	277	115

[a] Note in all tables, "Survey" denotes the 1-semester general chemistry course for engineering students; "1st Term" denotes the first semester of a two-semester general chemistry course and "2nd term" denotes the second semester of that course.

Next a calculation was devised to estimate the grade trajectory for each student. Thus, the difference between the final exam percentage score needed to earn each possible grade and their average percentage performance on semester

exams was determined. Values for these differences ranged from -99.83% to +73.26% as summarized in Table 3 by possible letter grade. Students who were unable to earn a particular grade were not included in that grade minimum and maximum determination. A negative value is interpreted as the number of percentage points a student could *under perform* relative to their average semester exam performance and still earn that letter grade. A positive value, then, is interpreted as the number of percentage points a student needs to *over perform* relative to their average semester exam performance and earn that letter grade.

Table 3. Minimum and Maximum Percentage Points Needed on the Final Exam to Earn Each Final Letter Grade

Course type / Date		*To get A*	*To get B*	*To get C*	*To get D*
Survey / F10	Min	-46.5	-51.7	-61.0	-61.6
	Max	73.3	61.8	52.1	33.6
Survey / F11	Min	-39.1	-54.4	-59.4	-60.3
	Max	68.4	64.4	54.4	34.4
Survey / F12	Min	-43.9	-54.3	-68.2	-54.7
	Max	57.9	58.9	54.7	33.1
1st Term / F10	Min	-61.5	-80.9	-74.5	-75.0
	Max	20.9	36.8	49.3	47.1
1st Term / F11	Min	-83.3	-90.8	-70.1	-61.5
	Max	30.9	45.8	52.3	72.7
1st Term / F12	Min	-56.8	-77.1	-82.5	-73.8
	Max	23.8	41.1	53.4	67.7
2nd Term / S11	Min	-49.7	-75.0	-78.8	-83.2
	Max	21.3	41.5	47.1	55.9
2nd Term / S12	Min	-58.1	-70.2	-76.7	-70.0
	Max	23.3	39.3	56.6	49.0
2nd Term / S13	Min	-58.3	-72.7	-87.3	-74.9
	Max	51.9	58.7	63.3	44.2

Looking more closely at Table 3 reveals the nature of the binary judgment made in this study. Because of the structure of resurrection point courses, students in them have potential access to higher letter grades than students have in non-resurrection point courses. To do so, however, they must dramatically over perform on the final exam compared to their hour exam average percentage. This

fact can be seen by comparing two different courses. For example, in the "survey" course in Fall 2010, at least one student had the chance to get an A by having a final exam 73.26 percentage points higher than their hour exam performance. By contrast, in the non-resurrection point 2nd-term class in Spring 2011, to obtain an A, the largest gap would have been 21.27 percentage points higher. Few, if any, of these students in fact do obtain the A in either course, but the availability of the higher grade is an important factor to consider when looking at the analysis that follows.

Finally, for each student, it was determined what letter grade would be assigned based on the percentage of points the student earned using cutoffs of A (90%), B (80%), C (70%), D (60%), or F (< 60%). Grade distributions were fairly similar among these nine courses, except for the Fall 2011 2nd semester STEM course for which the grade distribution was generally lower. Note that this choice of assigning achieved grade removes the possibility of adjustments made by instructors, something that may occur when students fall very close to a grade borderline. Because students are not able to predict what borderline adjustments might be, it is safe to expect that student effort in preparing for the final would have been based off the cutoff scale that is in the course syllabus, which is commensurate with the values used here.

Results and Discussion

To estimate the impact of resurrection points on the grade trajectory of students, there are several pertinent pieces of information presented here: (1) the number of students receiving resurrection points in the three classes implementing this motivational technique, (2) the number of students under and over performing to receive a particular grade, (3) a graphical representation of binary demarcation of student effort necessary on the final examination versus under or over performing, and (4) the odds of not receiving a particular grade if needing to over perform (the odds of receiving a particular grade would be more appropriate; however, the odds are all less then one and less accessible for interpretation).

Within the four courses implementing resurrection points, students received varying numbers of resurrection points (see Table 4). For this discussion, resurrection points are defined as the number of points added to the previous exam performance to raise their previous exam performance to reflect their performance on the respective exam material on the final exam. For the three "survey" courses for engineers, over 96% of students received some amount of resurrection points with 30 or more points being earned on average (roughly 5% of the total points for the course). The number of resurrection points *available* is determined by the performance on semester exams. On average, the survey courses for engineers scored less than 70% on semester exams. So, while the amount of points available varies by student, in total the class had a considerable opportunity to earn resurrection points. The 2nd semester general chemistry course for STEM majors only had about a third of the students receiving resurrection points with an approximate average of 4 points. Considering that the semester

exam average was 82% for this course, the students had less of an opportunity to earn resurrection points than did the students in the "survey" course for engineers. It is also possible that students in the "survey" course for engineers, being aware of the possibility of resurrection points gave *less time* to their chemistry studies during the hour exams, effectively under performing then.

Table 4. Summary of Resurrection Points Earned in Each General Chemistry Course

Course Type / Date	*N*	*% Students Earning Resurrection Points*	*Average Number of Resurrection Points Earned (SD)*
Survey / F10	746	99.6	44.0 (23.8)
Survey / F11	908	97.3	34.0 (22.6)
Survey / F12	955	96.3	30.3 (19.9)
1st Term / F10	902	n/a	n/a
1st Term / F11	1,041	n/a	n/a
1st Term / F12	1,155	n/a	n/a
2nd Term / S11	641	n/a	n/a
2nd Term / S12	697	n/a	n/a
2nd Term / S13	774	37.3	3.97 (8.56)

A student's need to under or over perform for a particular grade was determined as is presented in Table 5. The number of students receiving a particular grade (i.e. Got A, Got B, Got C, or Got D) by under or over performance is summarized in this table. By visual observation, it can be seen that students in the survey course for engineers more commonly over perform and receive a particular grade than students in either the 1st semester or 2nd semester general chemistry courses for STEM majors. The numbers are not, however, particularly large in any course.

A graphical depiction of these results emphasizes the binary nature of the analysis and is provided in Figures 1 and 2. The y-axis is marked as "1" receiving the grade or "0" not receiving the grade. The x-axis is the effort score, the difference between average performance during the semester and performance needed on the final examination to earn the particular grade. For ease of interpretation, a vertical red line marks 0 effort (i.e. average semester performance equal to performance needed on the final exam). Additionally, those needing to under perform are marked as blue dots; those needing to over perform are marked as red dots.

Table 5. Number of Students Under or Over Performing on the Final Exam for Each Final Letter Grade

Course Type / Date	N	n Students Under Performed and				n Students Over Performed and			
		Got A	Got B	Got C	Got D	Got A	Got B	Got C	Got D
Survey / F10	746	231	246	162	41	19	11	4	0
Survey / F11	908	159	288	230	99	27	30	12	8
Survey / F12	955	284	332	170	66	35	23	10	0
1st Term / F10	902	209	327	227	91	2	4	1	4
1st Term / F11	1,041	365	327	217	83	1	1	1	3
1st Term / F12	1,155	299	386	259	152	7	0	0	1
2nd Term / S11	641	49	190	176	169	1	0	3	2
2nd Term / S12	697	145	220	186	111	0	0	3	1
2nd Term / S13	774	221	274	162	79	0	1	1	0

To quickly assess the information contained in these graphs, the red dots in the upper right position represent students who obtain the higher grade by over performing on the final exam. Blue dots on the upper line obtain the higher grade, but were able to do so without over performing, on average, on the final exam. The lower line plots students who did not receive the higher grade. The graphical representation (i.e., Figures 1 & 2) readily show that many more students over perform and receive the grade (i.e., red dots on the upper line) in the survey courses for engineers than the other courses. Nonetheless, even in these courses, the number of students who over perform and receive the higher grade is smaller than those who over perform and do not (red dots on the lower line.) This evidence suggests that resurrection points are not inherently over-generous to students. Another value of these visual representations is that one can observe that many of the over performers were relatively close to the 0 effort mark (i.e., performance needed on the final examination was close to equivalent to performance on semester exams). In addition, looking at these graphs for the different grades, the majority of over performance resulting in a high grade occurs for grades of A or B. Relatively few students over perform to receive a C, for example, even when resurrection points are available. The idea that students who struggle with the material may gain less in measured performance from the use of this motivation tool is consistent with previous studies (*12*).
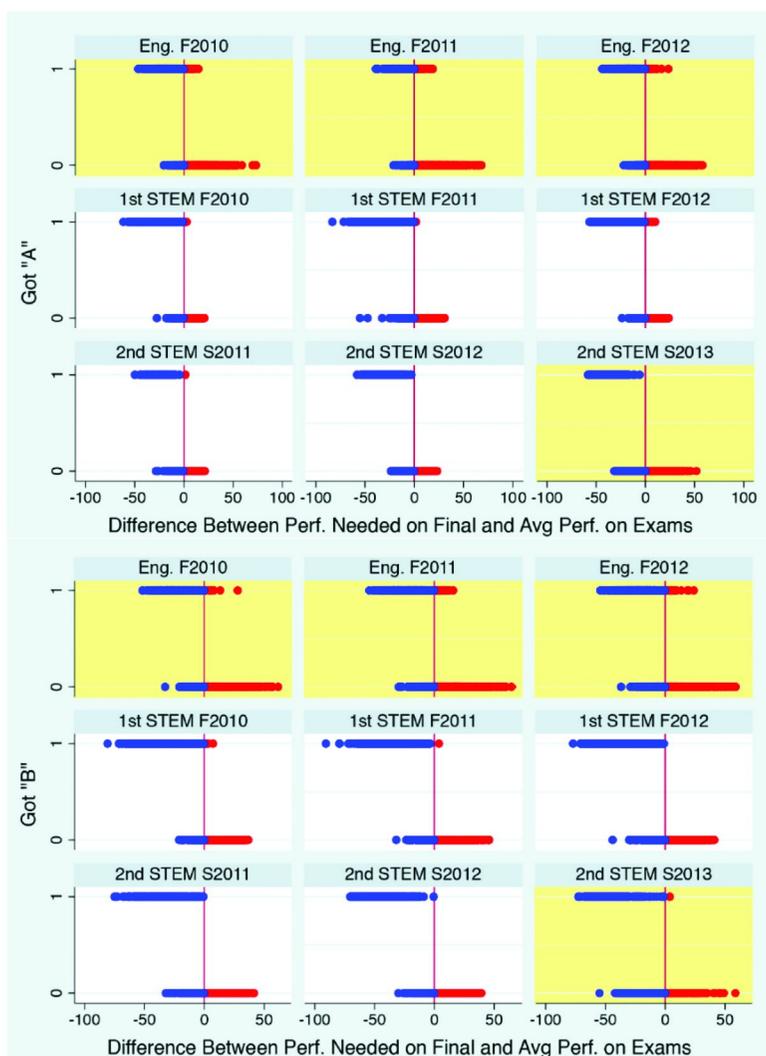
Figure 1. Graphical depiction of instances of under performance (blue dots) and over performance (red dots) as a function of course and grade level for grades of "A" and "B". Courses with a yellow background included resurrection points. For vertical axis, 0 means the grade depicted as not achieved and 1 means the grade was achieved.

As can be inferred from the numbers in Table 5, an attempt to *quantify* the possibility of over performance – the odds of over performing and receiving the particular grade – leads to a value less than one for all grades and all courses. Comparison of these numbers is possible, but the inverse ratio provides the same

information in a more readily digestible form. Thus, the odds of "not receiving the grade when the student must over perform on the final examination to receive it" are reported in Table 6. Across all nine courses, odds range from 17.22 to 817.50; odds ratios are only reported only if they are statistically significant ($p < 0.05$).
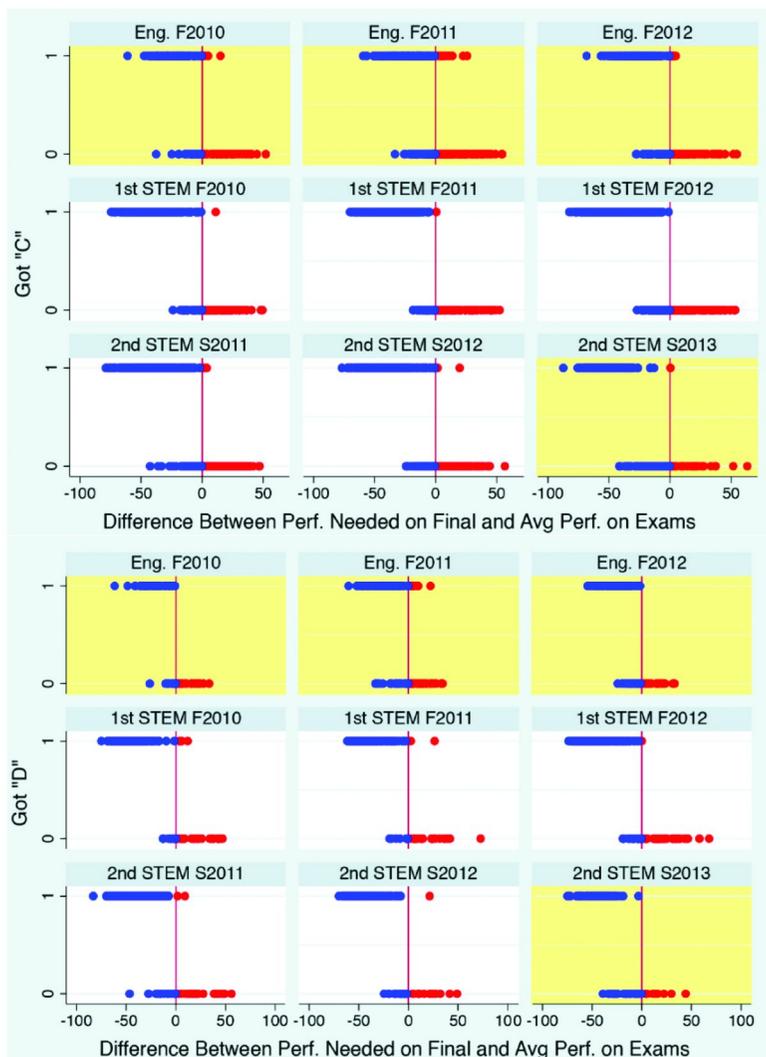

Figure 2. Graphical depiction of instances of under performance (blue dots) and over performance (red dots) as a function of course and grade level for grades of "C" and "D". Courses with a yellow background included resurrection points.

Table 6. Odds of Not Getting a Final Letter Grade if Needed to Over Perform on the Final Exam

Course Type / Date	N	Odds of "Not Getting" the Grade if Needed to Over Perform ($p < 0.05$ for reported odds)			
		A	B	C	D
Survey / F10	635	44.6	39.3	88.0	*
Survey / F11	908	33.9	25.2	30.9	17.2
Survey / F12	955	33.2	24.4	24.9	*
1st Term / F10	902	205.	240.	712.	65.4
1st Term / F11	1,040	715.	817.	581.	69.2
1st Term / F12	1,160	116.	*	*	431.
2nd Term / S11	641	70.0	*	124.	139.
2nd Term / S12	697	*	*	124.	96.2
2nd Term / S13	774	*	140.	55.3	*

These large numbers indicate that the odds are generally against, often strongly against, observing student over performance on a final exam to obtain a higher grade. In some courses the odds against over performing enough to earn a higher grade may be greater than 500 to 1. Many experienced instructors will see this data as confirmation for more anecdotal observations of students who convince themselves that they can "save" their grade via the final exam, often with unsuccessful results. Nonetheless, despite the overall large numbers present, there are important differences between courses that include resurrection points and those that do not. The largest odds against over performance are prevalent in the courses that do not provide the opportunity for resurrection points. In the resurrection points courses the odds tend to still be smaller, an average of 46 to 1 against making the higher grade, but less daunting. It is impossible to argue without qualitative, interview-style data whether students consciously choose an effort level based on their prospects for achieving a desired grade. Neither is it possible to adjudicate if students make accurate judgments about such prospects. Nonetheless, the difference in odds ratios obtained in the analysis summarized here is such that the difference in student performance is clear. The difference is not tied to individual instructors, as the courses studied have several instructors. It is not possible to prove that motivation associated with the availability of resurrection points are responsible for the difference, but the results noted suggest this as a plausible explanation.

This study did not have access to student performance in any other courses than chemistry, so it is not possible to determine the relative performance on the chemistry final compared to other topics taken by students in a given semester. Nevertheless, the overall message of this set of data appears to be that student

ability to over perform during finals is limited. At the same time, a technique like resurrection points seems to result in having occurrences of over performance become more common.

Conclusions and Implications

The hypothesis for this study was that the perceived motivational interest in earning resurrection points may lead to enhanced student motivation to study for a chemistry final. Extra studying would, in turn, lead to students being more likely to over perform on the final exam compared to their average semester exam performance; in other words change their grade trajectory. The current study does not preclude the design of an ideal experimental or quasi-experimental study related to this question but such a study would require instructors who believe that resurrection points are useful to deny this method to some fraction of their students, which is ethically troublesome. The study presented here does benefit from having data collected in three different general chemistry courses across three years and thereby provides several comparative implementations of resurrection points. Specifically, one course did not offer resurrection points ever (i.e., 1st semester STEM), one course offered resurrection points only in the last year of the study (i.e., 2nd semester STEM), and one course offered resurrection points for each year (i.e., Survey General Chemistry for Engineering Students). In addition, the 2nd semester course for science majors had different implementation style for resurrection points with students first learning about resurrection points in the middle of the semester in the last year of the study. Overall, regardless of the course or specific implementation, numerical results of course performance suggest that students were more likely to over perform and receive a particular grade in a resurrection-point course than a non-resurrection-point course. This result is consistent with the argument that at least some fraction of the students were differently motivated in resurrection point courses to relearn material missed on semester exams and study for the final exam.

This study is limited in several ways: First, student effort in preparing for the final examination was not actually measured. Measures of such constructs routinely involve self-report data, and such data is difficult to calibrate among students, so direct measures across difference courses would be more difficult to obtain and use. The idea of using performance during the semester to establish a grade trajectory to which is compared to performance on the final examination relative to that trajectory is argued to be a proxy for motivation. This choice encompasses an assumption that higher performance on the final exam likely reflects extra study efforts. It is certainly true that other unmeasured factors such as the number of finals a student had on the day of the general chemistry final exam may have affected student performance as well. Personal influences such as medical issues or family emergencies also may have an impact on student performance. Finally, the nature of final exams themselves, as arbiters of content knowledge likely plays a role in the results presented here. Comprehensive finals present challenges to students, but many teachers would agree that individual items on such exams are often less complex than those asked during hour exams.

This change in structure is practically important because of the relative size of the knowledge domain covered on the final exam. Even with this change, it is noteworthy that student over performance is uncommon in the empirical data presented here. These, and other, confounding variables have not been considered and could be the pursuit of future work in evaluating the educational impact and worth of resurrection points or any other pedagogical strategy as a motivational tool.

Second, despite the sample including three courses across three years, a relatively large available sample (over 7,000 students), with necessary variations of resurrection points versus non-resurrection points, the number of trials is ultimately small. Furthermore, most instructors perceive that individual classes have something like a "personality", and in some cases there is no obvious reason why one group of students seems to struggle with course materials more than the students in courses before or after them. There may be ways to control for some of the variables noted above, or at least measure them to investigate their potential impact relative to whether or not resurrection points are implemented in a class. Nonetheless, it is important to recognize that some instructors have used this method for over 20 years, and the ratio of student comments lauding resurrection points to those expressing concern (in venues such as course evaluations) is overwhelmingly towards the positive. Even if the odds of over performing are not particularly strong even with the availability of resurrection points, students tend to appreciate the opportunity to improve their grades in a systematic way.

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