Final Grade Outcomes and LMS Student Engagement:

An Exploratory Quantitative Analysis

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A college within an institution of higher education in east Texas is interested in determining if student engagement in their learning management system (LMS), Blackboard, is associated with a student's final grade. Obtaining data to answer this question requires gathering, cleaning, and assembling data from multiple institution systems. The institution's policies do not require a standardized approach to LMS gradebooks or the "overall grade" column across courses, rendering quantitative data within that column inconsistent. However, the institution's policies do require instructors to report a letter grade on a standardized and ordered scale (A, B, C, D, F, Q, W, WQ, and X) within their student information system (SIS), Banner. Student final grades reported in Banner were gathered and compared with engagement data gathered from Blackboard across face-to-face, hybrid, and online instructional modalities. The institution was interested in evaluating data recorded each semester from Spring 2023 through Spring 2025.

Research Question, Methods, and Hypotheses

In this analysis, I examine the following research question: Which LMS student engagement variables are associated with final grade outcomes reported in the SIS? To appropriately evaluate the association between student engagement in Blackboard (multiple numerical independent variables) and a student's final grade (ordinal dependent variable), a quantitative ordinal logistic regression analysis was performed. The null hypothesis (H_0) anticipates LMS student engagement is not associated with a student's final grade. The alternative hypothesis (H_1) anticipates that LMS student engagement is associated with a student's final grade.

Data Sources and Pre-Processing

Student final grades are recorded in Banner by faculty at the end of each term. Grade values are categorical and ordinal in nature ranging from A, B, C, D, F, Q, W, WQ, and X. Final grade values from Banner were grouped into five categories of A, B, C, D, and F/Other and recoded for analysis as the dependent variable, Final_Grade_Summary_Recode. Blackboard captures and stores a variety of student engagement metrics. The following eight metrics were selected for analysis. Within the “course access” student engagement report, access frequency (CAR_Access_frequency) and average weekly hours spent in a course (CAR_Weekly_average_time_in_course_hrs) variables were selected. Blackboard defines frequency of student access as a measure of the percentage of available days that a student visits a course. Within the “engagement with course content” student engagement report, weekly interactions with course content (ECC_Weekly_interaction_cout) and weekly total hours engaging with content (ECC_Weekly_total_hours) variables were selected. Within the “engagement with assessments” student engagement report, percent of on-time assessment submissions (EWA_On_time_Submissions_pct) and percent of late assessment submissions variables were selected. Blackboard defines the status (on-time versus late) assessment submissions based on the due date of the assessment. Within the “learning tools engagement” social and collaborative engagement report, percent of learning tool items accessed within a course (LTE_Items_accessed_pct) and percent of learning tool items with submissions within a course (LTE_Itemts_with_submissions_pct) variables were selected.

Final grade data from Banner was joined with student engagement data from Blackboard by student and course identifiers. Grade data from Banner included 71,237 rows and Blackboard’s student engagement data included 55,639 rows. Rows missing the last course access date and final grade were excluded from the analyzed dataset. Students auditing the courses were also excluded from the analyzed dataset. The cleaned data set analyzed with SPSS included 55,161 across all course modalities.

In Table 1 below, summary statistics are displayed for each of the eight variables across all instructional modalities.

Table 1

Descriptive Statistics for Student Engagement Metrics

Engagement Metric	Descriptive Statistic	Statistic Value
CAR_Access_frequency	N	55,161
	Range	0.8920
	Minimum	0.0048
	Maximum	0.8968
	Mean	0.3398
	Std. Deviation	0.1464
	Skewness	0.385
	Kurtosis	0.000
CAR_Weekly_average_time_in_course_hrs	N	55,161
	Range	69.91
	Minimum	0
	Maximum	69.91
	Mean	1.9431
	Std. Deviation	1.8577
	Skewness	4.395
	Kurtosis	62.756
ECC_Weekly_interaction_count	N	54,995
	Range	1,900.2394
	Minimum	0.0333
	Maximum	1,900.2727
	Mean	27.4694
	Std. Deviation	26.2134

	Skewness	13.434
	Kurtosis	669.916
ECC_Weekly_total_hours	N	54,995
	Range	69.8563
	Minimum	0
	Maximum	69.8563
	Mean	1.1341
	Std. Deviation	1.3296
	Skewness	5.224
	Kurtosis	143.790
EWA_On_time_Submissions_pct	N	51,134
	Range	1.0
	Minimum	0
	Maximum	1.0
	Mean	0.5890
	Std. Deviation	0.2951
	Skewness	-0.350
	Kurtosis	-0.916
EWA_Late_Submissions_pct	N	51,134
	Range	1.0
	Minimum	0
	Maximum	1.0
	Mean	0.0614
	Std. Deviation	0.1199
	Skewness	3.075
	Kurtosis	11.693
LTE_Items_accessed_pct	N	53,257

	Range	0.9811
	Minimum	0.0038
	Maximum	0.9848
	Mean	0.3898
	Std. Deviation	0.2324
	Skewness	0.533
	Kurtosis	-0.570
LTE_Items_with_submissions_pct	N	53,257
	Range	0.9247
	Minimum	0.0007
	Maximum	0.9254
	Mean	0.1980
	Std. Deviation	0.1716
	Skewness	1.606
	Kurtosis	2.567

Statistical Assumptions

Prior to conducting the ordinal regression analysis for each instructional modality, four statistical assumptions were checked. The first assumption of performing an ordinal regression relies upon measuring the dependent variable at the ordinal level. The "Final_Grade_Summary_Recode" variable measures grade values from F/Other = 1 up to A = 5. This assumption is met. The second assumption requires that the independent variables used are continuous, ordinal, or categorical (including dichotomous variables). All the independent variables are continuous, and the second assumption is met. The third assumption of an ordinal regression requires that there is no multicollinearity present between independent variables. Collinearity statistics were calculated for the independent variables across each instructional modality. Tables 2 through 4 below display variance inflation factor (VIF) statistics for each

variable by instructional modality. A VIF statistic greater than five indicates that variables are highly correlated and multicollinearity may be an issue.

Table 2

Collinearity Statistics for Student Engagement Variables in Face-to-Face Courses

Independent Variable	Tolerance	VIF
CAR_Access_frequency	0.495	2.018
CAR_Weekly_average_time_in_course_hrs	0.290	3.445
ECC_Weekly_interaction_count	0.531	1.882
ECC_Weekly_total_hours	0.455	2.198
EWA_On_time_Submissions_pct	0.629	1.590
EWA_Late_Submissions_pct	0.897	1.115
LTE_Items_accessed_pct	0.297	3.365
LTE_Items_with_submissions_pct	0.267	3.750

Table 3

Collinearity Statistics for Student Engagement Variables in Hybrid Courses

Independent Variable	Tolerance	VIF
CAR_Access_frequency	0.521	1.921
CAR_Weekly_average_time_in_course_hrs	0.325	3.078
ECC_Weekly_interaction_count	0.262	3.813
ECC_Weekly_total_hours	0.320	3.126
EWA_On_time_Submissions_pct	0.667	1.498
EWA_Late_Submissions_pct	0.771	1.297
LTE_Items_accessed_pct	0.356	2.809
LTE_Items_with_submissions_pct	0.355	2.813

Table 4

Collinearity Statistics for Student Engagement Variables in Online Courses

Independent Variable	Tolerance	VIF
CAR_Access_frequency	0.606	1.650
CAR_Weekly_average_time_in_course_hrs	0.282	3.545
ECC_Weekly_interaction_count	0.536	1.864
ECC_Weekly_total_hours	0.336	2.976
EWA_On_time_Submissions_pct	0.704	1.419
EWA_Late_Submissions_pct	0.867	1.154

LTE_Items_accessed_pct	0.360	2.778
LTE_Items_with_submissions_pct	0.344	2.907

None of the variables across each instructional modality exhibit a VIF statistic greater than five, and thus assumption three is satisfied. The last assumption is that the analysis results in proportional odds. This assumption means that each independent variable has an identical effect at each cumulative split of the ordinal dependent variable. The following tables display tests of parallel lines for each instructional modality. The null hypothesis visible in each table states that the location parameters (i.e., slopes) are the same across grade categories.

Table 5

Test of Parallel Lines for Final Grades in Face-to-Face Courses

Model	Chi-Square	Significance
Null Hypothesis		
General	664.783	<.001

Table 6

Test of Parallel Lines for Final Grades in Hybrid Courses

Model	Chi-Square	Significance
Null Hypothesis		
General	72.387	<.001

Table 7

Test of Parallel Lines for Final Grades in Online Courses

Model	Chi-Square	Significance
Null Hypothesis		
General	2,153.127	<.001

The assumption of proportional odds was tested using the Test of Parallel Lines, which yielded a significant result ($p<.05$) for each instructional modality. This result suggests that the

proportional odds assumption may be violated, however, given the large sample size of this data set, this test may be overly sensitive to small, practically insignificant deviations. To evaluate the goodness-of-fit of the model for each instructional modality, the tables below display Pearson Chi-Square and Deviance test statistics. The “Value/df" in each table should be above a 0.05 level (not significant) to exhibit a goodness-of-fit.

Table 8

Goodness of Fit for Final Grades in Face-to-Face Courses

Model	Value	df	Value/df
Pearson Chi-Square	80078.703	82820	0.967
Deviance	57258.013	82820	0.691

Table 9

Goodness of Fit for Final Grades in Hybrid Courses

Model	Value	df	Value/df
Pearson Chi-Square	3775.235	3956	0.954
Deviance	2338.730	3956	0.591

Table 10

Goodness of Fit for Final Grades in Online Courses

Model	Value	df	Value/df
Pearson Chi-Square	106992.674	113068	0.946
Deviance	72868.853	113068	0.644

Both the Pearson Chi-Square and Deviance goodness-of-fit statistics in each instructional modality indicate no significant lack of fit, suggesting that the model adequately represents the data overall. Therefore, while the violation of the proportional odds assumption should be acknowledged, the models are retained for analysis, and exactness of results should be interpreted with appropriate caution.

Ordinal Regression Results

Face-to-Face Courses

Within the face-to-face courses ordinal regression model, SPSS included 20,708 grades out of 24,543 possible grades for face-to-face courses, 84.4-percent of face-to-face course data. The likelihood ratio chi-square test found the hybrid course ordinal regression model to be statistically significant (χ^2 = 3,197.730, p=0.000). Within the model, CAR_Access_frequency (Wald χ^2 = 952.314, $p < .001$), ECC_Weekly_total_hours (Wald χ^2 = 11.766, p = 0.001), EWA_On_time_Submissions_pct (Wald χ^2 = 567.306, $p < .001$), EWA_Late_ Submissions_pct (Wald χ^2 = 210.664, $p < .001$), and (LTE_Items_accessed_pct (Wald χ^2 = 5.608, p = 0.018) were each found as significantly contributing to the model.

Each of these significant engagement factors impacted the odds of a student's ability to increase their final grade when enrolled in a face-to-face class. The odds of a student increasing their grade by consistently accessing blackboard throughout the semester were 64 (95% CI, 49 to 84) times that of students who didn't access blackboard consistently. As students spent more time accessing courses content through Blackboard each week the odds of receiving a higher grade diminished marginally, a 0.936 (95% CI, 0.901 to 0.972) odds multiplier. Turning in Blackboard assignments on time increased the odds of a student gaining a higher final grade by 3.8 (95% CI, 3.405 to 4.242) times. Inversely, turning in assignments late reduced the student's odds of getting a higher grade by 0.222 (95% CI, 0.181 to 0.272) times. Engaging with items associated with learning tools also had a negative effect on a student's odds of obtaining a higher grade, lowering their odds by 0.783 (95% CI, 0.640 to 0.959) times.

Hybrid Courses

Within the hybrid courses ordinal regression model, SPSS included 992 grades out of 995 possible grades for hybrid courses, 99.7-percent of hybrid course data. The likelihood ratio chi-square test found the hybrid course ordinal regression model to be statistically significant (χ^2

= 139.344, p=0.000). Within the model, CAR_Access_frequency (Wald χ^2 = 16.831, $p < .001$), ECC_Weekly_interaction_count (Wald χ^2 = 11.553, $p = 0.001$), LTE_Items_accessed_pct (Wald χ^2 = 12.420, $p < .001$), and LTE_Items_with_submissions_pct (Wald χ^2 = 51.878, $p <$ .001) were each found as significantly contributing to the model.

Each of these significant engagement factors impacted the odds of a student's ability to increase their final grade when enrolled in a hybrid class. The odds of a student increasing their grade by consistently accessing blackboard throughout the semester were 16 (95% CI, 4 to 62) times that of students who didn't access blackboard consistently. The odds of a student increasing their grade by increasing their interaction with course content in blackboard was marginal, a 1.031 (95% CI, 1.013 to 1.050) odds multiplier. Engaging with items associated with learning tools had a negative effect on a student's grade, lowering their odds of a higher grade by 0.112 (95% CI, 0.033 to 0.38) times. Conversely, engaging with learning tools to submit assignments or activities increased a student's odds of getting a higher grade by 2,364 (95% CI, 286 to 19,576) times. Additional breakdowns in learning tool engagement may yield additional insights.

Online Courses

Within the online courses ordinal regression model, SPSS included 28,270 grades out of 29,623 possible grades for online courses, 95.4-percent of online course data. The likelihood ratio chi-square test found the online course ordinal regression model to be statistically significant (χ^2 = 6768.708, p=0.000). Within the model, CAR_Access_frequency (Wald χ^2 = 2,102.717, $p < .001$), ECC_Weekly_total_hours (Wald χ^2 = 5.884, $p = 0.015$), EWA_On_time_Submissions_pct (Wald χ^2 = 1,383.891, $p < .001$), EWA_Late_Submissions_pct (Wald χ^2 = 115.453, $p < .001$), and LTE_Items_with_submissions_pct (Wald χ^2 = 42.348, $p <$ .001) were each found as significantly contributing to the model.

Each of these significant engagement factors impacted the odds of a student's ability to increase their final grade when enrolled in an online class. The odds of a student increasing their grade by consistently accessing blackboard throughout the semester was 124 (95% CI, 101 to 153) times that of students who didn't access blackboard consistently. The odds of a student increasing their grade by spending more time each week accessing content in blackboard were marginal, a 1.034 (95% CI, 1.006 to 1.062) odds multiplier. Turning in assignments on time increased the odds of a student gaining a higher final grade by 6.7 (95% CI, 6.071 to 7.419) times. Inversely, turning in assignments late reduced the odds of getting a higher grade by 0.3 (95% CI, 0.25 to 0.38) times. Additionally, engaging with learning tools to submit assignments or activities increased a student's odds of getting a higher grade by 2.184 (95% CI, 1.726 to 2.763) times.

Conclusion & Future Research

Ordinal regression analyses across face-to-face, hybrid, and online courses revealed that consistent and frequent Blackboard access was the strongest and most consistent predictor of higher student grades, with effect sizes ranging from 16 times greater odds in hybrid courses to 64 times in face-to-face courses and 124 times in online courses. On-time assignment submissions also significantly improved grade outcomes across all modalities, while late submissions consistently reduced the odds of success. Passive engagement, such as accessing content without completing submissions, tended to negatively impact performance. While weekly time spent accessing content or interaction counts with content had marginal effects, submitting assignments through Blackboard's learning tools had a particularly strong positive impact in hybrid and online course formats. These findings emphasize the importance of consistent, timely, and active engagement in digital learning environments, with the most pronounced effects observed in fully online courses.

Given the statistically relevant findings surrounding student engagement within Blackboard discussed earlier, the null hypothesis (H_0) anticipating that engagement is not associated with a student's final grade is not supported, thus we reject the null hypothesis in favor of the alternative hypothesis (H_1). Specifically, frequent and consistent access of course content through Blackboard and submitting assignments in Blackboard on-time have the largest odds at improving a student's final grade.

Expanding on this exploratory analysis, a future non-experimental quantitative study could examine this data through the lens of a more focused research question based on current literature relating to student engagement. Additionally, ensuring all statistical assumptions are upheld and using a stratified sampling approach, instead of using the entire sampling frame, could improve the strength and generalizability of the findings by proportionally controlling for demographic factors like major, student level, gender, and age.