Research Article

# Are We Similar? Differences in Grading Patterns among Departments in the Same College

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**Abstract**
Using a unique data set on institutional, instructor, and student characteristics, mixed effect models are estimated to identify factors correlated with class grade point averages (GPAs) over time among different departments in the College of Agriculture and Life Sciences (COALS) at Texas A&M University (TAMU). More departments show more potential grade inflation in the years 2004–2019 than during the years 1989–2003. After controlling for individual instructors, student characteristics appear to be more important than instructor and institutional characteristics, except for class size, in explaining GPAs. The number of students in a class is negatively correlated with grades for all departments and periods. If significant, increase in students' high school rank is positively correlated with university GPA. Graduate students, non-graduate instructors, visiting faculty, and lecturers tend to grade higher than professors. Out of the eight non-science, technology, engineering, and mathematics (STEM) departments, seven (87.5 percent) potentially encountered grade inflation. In contrast, out of the four STEM departments, only two (50 percent) experienced potential grade inflation.

## 1 Introduction

One cornerstone of academics is student grades. Given the importance of grades in academics, it is not surprising the number and range of studies concerned with examining different aspects of student grades. One aspect receiving attention since at least 1894 (Kohn 2002) is the empirical issue of grade inflation, an increase in student grades without an associated increase in knowledge and learning. Authors, however, disagree if grade improvement (increases in achievement or learning) and not inflation is giving rise to increasing grades (Kuh and Hu 1999; Boretz 2004; Mostrom and Blumberg 2012). A major concern with grade inflation is the existence of inflation may lead to a misallocation of resources since grades lose their ability to distinguish students' abilities. Grade inflation may also lead to other misallocations of resources.

Competition for students and increasing tuition and costs may lead universities to allow grade inflation in the hopes of increasing their reputation, increasing enrollment, and justifying tuition increases (Jewell, McPherson, and Tieslau 2013). Attracting additional students may also provide the university more funds through tuition and fees (Teixeira et al. 2014), but higher than deserved grades will eventually negatively affect the reputation of a university for failing to prepare professionals that meet industries' expectations (Chowdhury 2018). Using student success as a metric for measuring institution's performance may lead to higher grades. As noted by O'Neill (2015), if graduation rates are a criterion, universities may either improve teaching and student motivation or resort to the less expensive way of increasing graduation rates, such as lowering standards.

Concerns over graduation rates, such as those highlighted in recent proposed legislation, the College Completion Fund Act of 2021, may enable grade inflation. This legislation has the intent to ensure more students complete college and enjoy the benefits of a college degree (GovInfo 2022), and may result in lowering standards because it stresses completion rates in the bill. Denning et al. (2022)

provide reasons why one might expect decreasing graduation rates such as increasing tuition costs, increase in hours worked by students, and less time spent studying. They, however, note completion rates have been increasing rather than decreasing partially because of increasing grade point averages (GPAs). Although grade inflation may be addressing the social problem of low completion rates, it does so at the costs of potential declining college wage premium associated with decreased learning (Denning et al. 2022).

Besides distinguishing student abilities and funding, grades may lead to misallocation of students. Hermanowicz and Woodring (2019, p. 497) note, “Grades are a ubiquitous part of college,” influencing a large part of undergraduate life from self-definition to graduation and job prospects (Rojstaczer and Healy 2012). With grades being such an important part of undergraduate life, it is no surprise studies such as Butcher, McEwan, and Weerapana (2014) and Opstad (2020) show grades may influence students’ choice of majors. Further, different grading norms can be used to manage demand for majors (Diette and Raghav 2015; Hernández-Julián and Looney 2016). Several studies have shown grading norms may differ between universities, colleges, and even different departments within a college in a university (Hartnett and Centra 1977; Achen and Courant 2009; Herron and Markovich 2017; Bond and Mumford 2019). Although these studies suggest there are differences in grading patterns between departments of a college or university, they provide no clear evidence on factors causing these differences.

Using a unique data set, hierarchical mixed effect models are used to identify factors influencing grades in departments in College of Agriculture and Life Sciences (COALS) at Texas A&M University (TAMU). Interviews with different departments’ personnel and comparative analysis of exogenous factors are implemented to better understand grades over time. The objectives are to:

1) Determine if potential grade inflation has been occurring by department and if it differs over time, and
2) Examine factors influencing mean class GPA among different departments in COALS to provide information on factors correlated with these differences and explore if the correlations have changed over time.

This study contributes to the existing literature in that it considers a wide array of factors affecting grades in different disciplines and draws parallels among departments. COALS includes a wide range of disciplines, which allows comparisons among the disciplines making the results more generalizable to other universities. Grades over time and differences in factors affecting grades may be used by the departments’ administrations to understand whether the changes in grading patterns are the result of improved learning or are consequences of inflated grades.

## 2 Literature Review

In the past decades, there has been intense competition among universities for high school graduates (Smith, Pender, and Howell 2017). One reason for this competition is decreasing government spending on public education (Cattaneo et al. 2016), which forces universities to attract funding through additional sources, including student tuition and fees (Teixeira et al. 2014). Universities must either increase tuition and fees or enroll more students to address budget shortfalls. Both tasks are challenging. Justification for tuition and fees increases includes improved services and quality of education, which often leads to additional expenditures (Archibald and Feldman 2012). In addition, students’ mobility and geographic integration of college markets (Hoxby 2000), as well as emergence of online education make attracting additional students harder. In this competitive environment, some universities try to increase their image and reputation while others, rather than engaging in expensive competition, simply accept weaker students (Jefferson, Gowar, and Naef 2019). Peace (2017) argues that even weaker students expect good grades in return for high tuition and fees. This notion of "consumerism" creates pressure on institutions to grant higher than deserved grades. Instructors as well may be inclined to grade leniently to avoid time-consuming arguments with students, especially on assignments that may not have a right or wrong answer (Achen and Courant 2009). There is also a labor market justification for granting higher than deserved grades. Graduates from disciplines with higher paying jobs generally have lower grades compared to those graduating from lower pay job disciplines. This grade disparity may be used to attract students to the lower wage disciplines (Sabot and Wakeman-Linn 1991; Freeman 1999; Diette and Raghav 2016).

Evidence of grade inflation and factors affecting grades are the subject of numerous studies over the past decades (e.g., Birnbaum 1977; Kohn 2002; Schutz et al. 2015; Kostal, Kuncel, and Sackett 2016; Peace 2017). Kuh et al. (2006) and Rojstaczer and Healy (2012) find that even after accounting for student aptitude, grades still increased in recent decades. In addition to student characteristics, Yeritsyan, Mjelde, and Litzenberg (2022) also control for instructor-specific and institutional factors but still find grades have increased statistically significantly between 1985 and 2019. Denning et al. (2022) take a different approach and compare end of year test grades and students' GPAs. Over the span of twelve years, students earned better course grades in later years, although end of course exam scores stayed nearly the same (nine out of twelve exams were identical).

Grade inflation as a way of distinguishing student abilities is recognized to be one of the most important issues facing the academic world (Merrow 2004) for at least two reasons. First, inflated grades do not convey the proper message concerning students' abilities and knowledge to future employers. A student with a "B" from an institution where grade inflation is not occurring may be better prepared for the job market compared to a student with an "A" from an institution where grade inflation occurred. Employers without knowledge of grade inflation may be tempted to hire the graduate with higher grades. Second, because grades have a cap (usually 4.0), grade inflation places a good student close to an exceptional student, thus negating the ability of grades to differentiate between students even in the same institution (Kohn 2002).

Differences in grading standards are observed not only between different universities (Popov and Bernhardt 2013), but also between departments within the same university (Sabot and Wakeman-Linn 1991; Herron and Markovich 2017), and even between instructors in the same department (Jewell and McPherson 2012). Hartnett and Centra (1977) discuss departmental differences from the standpoint of students' aptitudes and preparedness. They find significant department-specific differences in student learning outcomes. Several other studies highlight grade differences between science, technology, engineering, and mathematics (STEM) majors and non-STEM majors within the same universities (Ost 2010; Witteveen and Attewell 2020). One common finding is STEM departments tend to grade tougher than departments granting non-STEM degrees. Tougher grading may result in a smaller number of students enrolling in STEM-related disciplines (Rask 2010). Bar, Kadiyali, and Zussman (2009) concur with this finding, adding publicly available grade distributions make it possible for students to self-select into leniently graded classes. Opstad (2020) suggests students may self-select career pathways based on grades; below average-performing students may select majors other low-performing students select. The reason given is it may be easier for a student to obtain a good grade when competing against peer students who are also low performing or less qualified. Studies such as Hartnett and Centra (1977), Achen and Courant (2009), and Herron and Markovich (2017) highlight differences in grading patterns between departments in a college or university. Specific reasons behind the differences, as well as any suggested course of action, are usually not discussed.

## 3 Data Description and Summary Statistics

Differences in grading patterns are examined for a period of 31 years (from Spring 1989 through Fall 2019), which provides longer coverage than most studies. Data observations are for individual classes (class level data) from Yeritsyan, Mjelde, and Litzenberg (2022). Twelve departments (some departments have had name changes over the period) within COALS at TAMU included in the study are as follows, along with the department's four letter designation and shortened name for brevity in the text.

- Department of Agricultural Economics (AGEC) – Ag. Economics
- Department of Agricultural Leadership Education and Communications (ALEC) – Ag. Leadership
- Department of Animal Science (ANSC) – Animal Science
- Department of Biochemistry and Biophysics (BICH) – Biochemistry
- Department of Biological and Agricultural Engineering (BAEN) – Ag. Engineering
- Department of Entomology (ENTO) – Entomology
- Department of Horticultural Sciences (HORT) – Horticulture
- Department of Plant Pathology and Microbiology (PLPA) – Plant Pathology
- Department of Poultry Science (POSC) – Poultry Science
- Recreation, Park, and Tourism Sciences (RPTS) – Recreation and Parks
- Department of Soil and Crop Sciences (SCSC) – Soil and Crops
- Wildlife and Fisheries Management (WFSC) – Wildlife Management

Data were compiled using information from TAMU, departmental websites, and undergraduate catalogs. Missing data were collected through open access web sources, emails to instructors, and conversations with staff and faculty in different departments (Yeritsyan, Mjelde, and Litzenberg 2022). Classes of less than five students, individual problems, summer semesters, and study abroad are not included in the data.

Because what happened in the distant past may not be as relevant as the present, the data is divided into two periods, 1989–2003 and 2004–2019, which divides the data in approximately two equal periods. Unfortunately, no one event or policy change exists that suggests a date for dividing the data; however, the date roughly corresponds to changes in generations attending college and several policy implications. Around this date, Baby Boomers II (Also known as Generation Jones - born 155-68) were finishing college and Millennials (born 1981-1996) were starting college. Generation X (born 1965-1996) attended college in both periods. . Second, starting in the mid-1980s to mid-2000s, the university implemented policy changes affecting the number of credits necessary to graduate and tuition. These changes are discussed in the student characteristics section.

While differences between periods help in long-term trends, the recent period may be more relevant for addressing policy changes. Thus, the comparative analysis is implemented among departments and within each department between the two periods. GPAs are analyzed as a function of institutional (class time and duration, number of credits, upper or lower division courses, and number of total students in the class) instructor-related (instructor gender, position, and graduating from a university accredited by Association of American Universities (AAU)), and student-related (class averages of student gender, high school percentile or rank, SAT score, class load, and no grade) characteristics (Table 1). Summary statistics, along with tests of differences in the mean values of the variables by period, are in Table 2. Finally, because the data are for class and not department, any class may include students from multiple departments.

**Table 1: Description of the Variables Used in the GPA Models**

| Variable Name | Description |
|---|---|
| GPA | Class mean GPA |
| Ln trend | Natural logarithm of trend as given by semester |
| Morning | Equals 1 if class starts before 12:01, 0 otherwise |
| Afternoon | Equals 1 if class starts between 12:01 to 15:59, 0 otherwise (dropped to avoid perfect collinearity) |
| Meet 1 | Equals 1 if the class meets once per week—usually class duration is 2.5 hours for a three-credit class, 0 otherwise (dropped to avoid perfect collinearity) |
| Meet 2 | Equals 1 if the class meets twice per week—usually class duration is 75 minutes for a three-credit class, 0 otherwise |
| Meet 3 | Equals 1 if the class meets three times per week—usually class duration is 50 minutes for a three-credit class, 0 otherwise |
| Lower division | Equals 1 if the class is listed as a 100 or 200 level class, 0 otherwise (dropped to avoid perfect collinearity) |
| Upper division | Equals 1 if the class is listed as a 300 or 400 level class, 0 otherwise |
| Total students | Number of students receiving a grade A–F and no grades (see share below) in the class |
| Low credit | Equals 1 if the class is 1 or 2 credit hours, 0 otherwise—very few classes are 2 credits (dropped to avoid perfect collinearity) |
| High credit | Equals 1 if the class is 3 credit hours or more, 0 otherwise—very few classes have more than 3 credits |
| Instructor | Instructor name used as a level, 1,377 instructors |
| Instructor gender | Gender of the instructor, male = 1 and female = 0 |
| Professor | Equals 1 if the position at the time of instruction was professor, 0 otherwise (dropped to avoid perfect collinearity) |
| Associate prof | Equals 1 if the position at the time of instruction was associate professor, 0 otherwise |
| Assistant prof | Equals 1 if the position at the time of instruction was assistant professor, 0 otherwise |
| Lecturer graduate | Equals 1 if the position at the time of instruction was graduate student, 0 otherwise |
| Other lecture | Equals 1 if the position at the time of instruction was other lecturer, 0 otherwise (includes visiting faculty, lecturers, non-graduate instructors) |
| AAU | Equals 1 if the university was AAU member at the time of the instructor's graduation (includes Canadian universities), 0 otherwise |

**Table 1 continued.**

| Variable Name | Description |
|---|---|
| Student gender | Percentage of male students in the class |
| SAT | Class average of students' combined SAT math scores |
| Student load | Average number of credits students in the class are enrolled |
| HS percentile | The average high school rank of students in the class, calculated as the percentile of students in the school that rank below the given student |
| Share no grade | Share of students who enrolled in the class but did not receive an A–F grade for the class. Includes students who dropped beyond the initial drop date, received an incomplete grade, took the class pass/fail, or was dropped from the class by the dean's office divided by total students |

## 3.1 Departmental GPAs

Department mean GPAs show variability by department, years, and between the two periods (Figure 1). For presentation purposes, the departments are grouped into four subgroups. This grouping consists of Social Sciences, Animal Oriented, Plant Oriented, and Other. All departments' (except Horticulture, Soil and Crop Sciences, and Poultry Science) mean differences between the two period's GPAs are statistically significant (hence the word "significant" is used for ease of reading) at *p* values of 0.05 or less (Table 2). Three departments, Ag. Leadership, Ag. Engineering, and Wildlife Management, had significant decreases in mean GPAs in the second period relative to the first period. The remaining six departments had positive significant increases. Mean departmental GPAs range from 2.91 (Recreation and Parks) to 3.61 (Ag. Leadership) in the first period, and 3.00 (Wildlife Management) to 3.48 (Animal Science) in the second period. Even within the same grouping, departments have different grading patterns. Within the Social Sciences grouping (Ag. Economics, Recreation and Parks, and Ag. Leadership), Recreation and Parks GPAs, for example, are relatively flat in the first period but show a steady increase in the second period, while Ag. Economics GPAs show a slight increasing trend through most of the first period, then a flat or decreasing trend for the first part of the second period, and an increasing trend after that until the end.

## 3.2 Institutional Characteristics

Most classes meet in the morning. Only Plant Pathology has less than 50 percent of their classes in the morning. The percentage of classes in the morning range from nearly 82 percent for Animal Science and Entomology in the first period to 38 percent in Plant Pathology in the second period. Except for Plant Pathology and Poultry Science, all departments showed a significant decrease in morning classes with the corresponding increase in afternoon classes between the two periods. There appears to be no common tendency for the number of times courses meet. Most classes in COALS are upper division (junior and senior) classes with all departments having 53 percent or more of their classes being upper division. In the first period, Horticulture and Entomology are the only departments that had nearly equal split between lower division (freshmen and sophomore) and upper division classes. However, in the second period, they increase the share of upper division classes.

**Table 2: Variable Mean Values in Periods 1 and 2 and t-tests for Differences in Mean Values**

| | | Social Sciences | | | Plant Oriented | | | Animal Oriented | | | Other | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Variable | Period | AGEC | ALEC | RPTS | HORT | PLPA | SCSC | ANSC | POSC | BAEN | BICH | ENTO | WFSC |
| GPA | 1 | 2.987 | 3.609 | 2.911 | 3.414 | 3.009 | 3.043 | 3.307 | 3.213 | 3.262 | 3.015 | 3.150 | 3.095 |
| | 2 | 3.098 | 3.474 | 3.073 | 3.435 | 3.250 | 3.100 | 3.482 | 3.280 | 3.179 | 3.085 | 3.261 | 2.998 |
| | Diff. | 0.111* | -0.135* | 0.162* | 0.021 | 0.241* | 0.057 | 0.175* | 0.067 | -0.083* | 0.070* | 0.111* | -0.097* |
| **Institutional Variables** | | | | | | | | | | | | | |
| Morning | 1 | 0.657 | 0.726 | 0.691 | 0.747 | 0.480 | 0.702 | 0.815 | 0.621 | 0.805 | 0.622 | 0.819 | 0.685 |
| | 2 | 0.556 | 0.548 | 0.518 | 0.564 | 0.384 | 0.602 | 0.714 | 0.647 | 0.668 | 0.560 | 0.517 | 0.591 |
| | Diff. | -0.101* | -0.178* | -0.173* | -0.183* | -0.096 | -0.100* | -0.101* | 0.026 | -0.137* | -0.062* | -0.302* | -0.094* |
| After-noon | 1 | 0.343 | 0.272 | 0.309 | 0.253 | 0.520 | 0.298 | 0.185 | 0.379 | 0.195 | 0.378 | 0.181 | 0.315 |
| | 2 | 0.444 | 0.452 | 0.482 | 0.436 | 0.616 | 0.398 | 0.286 | 0.353 | 0.332 | 0.440 | 0.483 | 0.409 |
| | Diff. | 0.101* | 0.178* | 0.173* | 0.183* | 0.096 | 0.100* | 0.101* | -0.026 | 0.137* | 0.062* | 0.302* | 0.094* |
| Meet 1 | 1 | 0.000 | 0.444 | 0.170 | 0.386 | 0.440 | 0.284 | 0.448 | 0.316 | 0.276 | 0.195 | 0.046 | 0.172 |
| | 2 | 0.068 | 0.349 | 0.063 | 0.472 | 0.530 | 0.232 | 0.502 | 0.226 | 0.103 | 0.229 | 0.295 | 0.287 |
| | Diff. | 0.068* | -0.095* | -0.107* | 0.086* | 0.090 | -0.052 | 0.054* | -0.090* | -0.173* | 0.034 | 0.249* | 0.115* |
| Meet 2 | 1 | 0.579 | 0.534 | 0.439 | 0.593 | 0.353 | 0.369 | 0.362 | 0.353 | 0.514 | 0.419 | 0.858 | 0.737 |
| | 2 | 0.634 | 0.530 | 0.581 | 0.511 | 0.315 | 0.437 | 0.300 | 0.380 | 0.620 | 0.460 | 0.513 | 0.665 |
| | Diff. | 0.055* | -0.004 | 0.142* | -0.082* | -0.038 | 0.068* | -0.062* | 0.027 | 0.106* | 0.041 | -0.345* | -0.072* |
| Meet 3 | 1 | 0.421 | 0.022 | 0.390 | 0.021 | 0.207 | 0.348 | 0.190 | 0.331 | 0.210 | 0.386 | 0.096 | 0.090 |
| | 2 | 0.298 | 0.122 | 0.355 | 0.017 | 0.156 | 0.331 | 0.198 | 0.395 | 0.277 | 0.311 | 0.192 | 0.048 |
| | Diff. | -0.123* | 0.100* | -0.035 | -0.004 | -0.051 | -0.017 | 0.008 | 0.064 | 0.067* | -0.075* | 0.096* | -0.042* |
| Lower division | 1 | 0.109 | 0.142 | 0.244 | 0.472 | 0.107 | 0.13 | 0.34 | 0.401 | 0.293 | 0.037 | 0.448 | 0.144 |
| | 2 | 0.134 | 0.124 | 0.153 | 0.347 | 0.123 | 0.158 | 0.338 | 0.214 | 0.12 | 0.042 | 0.315 | 0.078 |
| | Diff. | 0.025 | -0.018 | -0.091* | -0.125* | 0.016 | 0.028 | -0.002 | -0.187* | -0.173* | 0.005 | -0.133* | -0.066* |
| Upper division | 1 | 0.891 | 0.858 | 0.756 | 0.528 | 0.893 | 0.870 | 0.660 | 0.599 | 0.707 | 0.963 | 0.552 | 0.856 |
| | 2 | 0.866 | 0.876 | 0.847 | 0.653 | 0.877 | 0.842 | 0.662 | 0.786 | 0.880 | 0.958 | 0.685 | 0.922 |
| | Diff. | -0.025 | 0.018 | 0.091* | 0.125* | -0.016 | -0.028 | 0.002 | 0.187* | 0.173* | -0.005 | 0.133* | 0.066* |
| Total students | 1 | 62.195 | 55.688 | 43.32 | 45.514 | 36.507 | 45.576 | 63.775 | 39.342 | 31.185 | 62.711 | 41.915 | 41.846 |
| | 2 | 69.773 | 40.612 | 46.967 | 48.201 | 41.414 | 47.063 | 62.718 | 40.282 | 35.971 | 48.602 | 53.942 | 34.300 |
| | Diff. | 7.578* | -15.080* | 3.647* | 2.687 | 4.907 | 1.488 | -1.057 | 0.940 | 4.786* | -14.110* | 12.027* | -7.546* |

**Table 2 continued.**

| Variable | Period | Social Sciences AGEC | ALEC | RPTS | Plant Oriented HORT | PLPA | SCSC | Animal Oriented ANSC | POSC | BAEN | Other BICH | ENTO | WFSC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Low credit | 1 | 0 | 0.51 | 0.129 | 0.378 | 0.327 | 0.2857 | 0.481 | 0.305 | 0.274 | 0.266 | 0.043 | 0.164 |
| | 2 | 0.017 | 0.192 | 0.043 | 0.35 | 0.474 | 0.199 | 0.498 | 0.276 | 0.098 | 0.28 | 0.235 | 0.147 |
| | Diff. | 0.017* | -0.318* | -0.086* | -0.028 | 0.147* | -0.087* | 0.017 | -0.029 | -0.176* | 0.014 | 0.192* | -0.017 |
| High credit | 1 | 1.000 | 0.490 | 0.871 | 0.622 | 0.673 | 0.7143 | 0.519 | 0.695 | 0.726 | 0.734 | 0.957 | 0.836 |
| | 2 | 0.983 | 0.808 | 0.957 | 0.650 | 0.526 | 0.801 | 0.502 | 0.724 | 0.902 | 0.720 | 0.765 | 0.853 |
| | Diff. | -0.017* | 0.318* | 0.086* | 0.028 | -0.147* | 0.087* | -0.017 | 0.029 | 0.176* | -0.014 | -0.192* | 0.017 |
| **Instructor Variables** | | | | | | | | | | | | | |
| Instruct. gender | 1 | 0.951 | 0.611 | 0.782 | 0.764 | 0.627 | 0.967 | 0.859 | 0.960 | 0.890 | 0.779 | 0.993 | 0.912 |
| | 2 | 0.914 | 0.461 | 0.694 | 0.846 | 0.798 | 0.887 | 0.786 | 0.905 | 0.800 | 0.695 | 0.798 | 0.860 |
| | Diff. | -0.037* | -0.150* | -0.088* | 0.082* | 0.171* | -0.080* | -0.073* | -0.055* | -0.090* | -0.083* | -0.195* | -0.052* |
| Professor | 1 | 0.546 | 0.195 | 0.294 | 0.376 | 0.340 | 0.484 | 0.446 | 0.386 | 0.499 | 0.478 | 0.918 | 0.539 |
| | 2 | 0.654 | 0.148 | 0.214 | 0.506 | 0.629 | 0.489 | 0.437 | 0.309 | 0.478 | 0.378 | 0.495 | 0.585 |
| | Diff. | 0.108* | -0.047* | -0.079* | 0.131* | 0.289* | 0.004 | -0.009 | -0.077* | -0.020 | -0.100* | -0.423* | 0.046 |
| Assistant prof | 1 | 0.138 | 0.230 | 0.235 | 0.093 | 0.093 | 0.029 | 0.129 | 0.081 | 0.123 | 0.104 | 0.050 | 0.132 |
| | 2 | 0.109 | 0.294 | 0.130 | 0.034 | 0.126 | 0.130 | 0.112 | 0.315 | 0.122 | 0.116 | 0.165 | 0.090 |
| | Diff. | -0.029 | 0.064* | -0.105 | -0.058* | 0.032 | 0.101* | -0.016 | 0.234* | -0.001 | 0.012 | 0.115* | -0.042* |
| Assoc. prof | 1 | 0.194 | 0.227 | 0.205 | 0.117 | 0.240 | 0.327 | 0.167 | 0.346 | 0.257 | 0.197 | 0.028 | 0.178 |
| | 2 | 0.091 | 0.249 | 0.243 | 0.105 | 0.215 | 0.294 | 0.260 | 0.252 | 0.241 | 0.166 | 0.194 | 0.224 |
| | Diff. | -0.102* | 0.021 | 0.038 | -0.012 | -0.025 | -0.033 | 0.093* | -0.093* | -0.016 | -0.031 | 0.166* | 0.046 |
| Lecturer graduate | 1 | 0.068 | 0.285 | 0.138 | 0.184 | 0.313 | 0.077 | 0.185 | 0.074 | 0.019 | 0.040 | 0.004 | 0.072 |
| | 2 | 0.054 | 0.165 | 0.206 | 0.057 | 0.000 | 0.003 | 0.140 | 0.077 | 0.019 | 0.021 | 0.049 | 0.057 |
| | Diff. | -0.014 | -0.119* | 0.068* | -0.126* | -0.313* | -0.074* | -0.044* | 0.004 | 0.000 | -0.019* | 0.045* | -0.016 |
| Other lecturer | 1 | 0.055 | 0.063 | 0.129 | 0.231 | 0.012 | 0.083 | 0.074 | 0.114 | 0.102 | 0.181 | 0.000 | 0.078 |
| | 2 | 0.091 | 0.144 | 0.208 | 0.297 | 0.030 | 0.084 | 0.051 | 0.047 | 0.139 | 0.319 | 0.097 | 0.044 |
| | Diff. | 0.037* | 0.081* | 0.079* | 0.066* | 0.028 | 0.001 | -0.023* | -0.066* | 0.038 | 0.138* | 0.097* | -0.034* |
| Non-AAU | 1 | 0.595 | 0.526 | 0.566 | 0.512 | 0.827 | 0.542 | 0.753 | 0.691 | 0.843 | 0.513 | 0.566 | 0.816 |
| | 2 | 0.385 | 0.561 | 0.586 | 0.554 | 0.659 | 0.574 | 0.549 | 0.472 | 0.711 | 0.476 | 0.348 | 0.711 |
| | Diff. | -0.210* | 0.035 | 0.020 | 0.042 | -0.168* | 0.032 | -0.204* | -0.219* | -0.132* | -0.037 | -0.218* | -0.105* |

**Table 2 continued.**

| | | Social Sciences | | | Plant Oriented | | | Animal Oriented | | Other | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Variable** | **Period** | **AGEC** | **ALEC** | **RPTS** | **HORT** | **PLPA** | **SCSC** | **ANSC** | **POSC** | **BAEN** | **BICH** | **ENTO** | **WFSC** |
| | | | | | | **Student Variables** | | | | | | | |
| Student gender | 1 | 0.650 | 0.516 | 0.502 | 0.398 | 0.555 | 0.739 | 0.493 | 0.656 | 0.802 | 0.445 | 0.591 | 0.561 |
| | 2 | 0.648 | 0.424 | 0.418 | 0.358 | 0.461 | 0.706 | 0.320 | 0.557 | 0.781 | 0.400 | 0.411 | 0.508 |
| | Diff. | -0.003 | -0.092* | -0.084* | -0.040* | -0.093* | -0.033* | -0.173* | -0.099* | -0.022* | -0.045* | -0.180* | -0.054* |
| SAT | 1 | 536.455 | 528.940 | 528.022 | 541.225 | 549.957 | 547.436 | 546.728 | 525.742 | 563.844 | 603.335 | 551.364 | 554.240 |
| | 2 | 550.955 | 527.968 | 543.309 | 558.052 | 569.051 | 549.944 | 560.975 | 532.083 | 592.254 | 623.538 | 576.754 | 568.296 |
| | Diff. | 14.500* | -0.973 | 15.287* | 16.827* | 19.094* | 2.508 | 14.247* | 6.341* | 28.410* | 20.204* | 25.391* | 14.056* |
| Student load | 1 | 14.147 | 14.223 | 13.762 | 13.974 | 13.918 | 14.016 | 14.063 | 14.323 | 14.227 | 14.127 | 13.974 | 13.934 |
| | 2 | 13.678 | 14.114 | 14.129 | 14.019 | 13.955 | 13.924 | 13.854 | 14.286 | 14.031 | 13.853 | 14.019 | 14.084 |
| | Diff. | -0.468* | -0.109* | 0.367* | 0.045* | 0.038 | -0.092* | -0.209* | -0.037 | -0.196* | -0.274* | 0.045 | 0.150* |
| HS percent. | 1 | 76.302 | 76.146 | 73.970 | 78.296 | 79.295 | 78.355 | 81.741 | 73.857 | 81.949 | 88.209 | 80.167 | 79.897 |
| | 2 | 73.042 | 73.031 | 73.324 | 78.867 | 80.296 | 74.064 | 83.701 | 74.391 | 81.056 | 87.655 | 83.949 | 80.583 |
| | Diff. | -3.260* | -3.115* | -0.646 | 0.571 | 1.001 | -4.291* | 1.960* | 0.534 | -0.893 | -0.554* | 3.782* | 0.686 |
| Share no grade | 1 | 0.039 | 0.019 | 0.043 | 0.032 | 0.040 | 0.041 | 0.026 | 0.027 | 0.021 | 0.063 | 0.030 | 0.042 |
| | 2 | 0.026 | 0.019 | 0.042 | 0.027 | 0.019 | 0.031 | 0.022 | 0.027 | 0.017 | 0.051 | 0.028 | 0.037 |
| | Diff. | -0.014* | 0.000 | -0.001 | -0.005* | -0.021 | -0.010* | -0.004* | 0.000 | -0.004* | -0.012 | -0.003 | -0.005 |

*Note*: * denotes statistical significance at 0.05 or lower ($p$ value < 0.05). See text for definitions of department acronyms.


**Figure 1: College of Agriculture and Life Sciences Departments' Average GPAs by Semester from 1989 to 2019**

Ag. Leadership, Biochemistry, and Wildlife Management show significant decreases in average student enrollment in classes, whereas Horticulture, Plant Pathology, Soil and Crops, Animal Science, and Poultry Science had no changes in average student enrollment per class between the two periods. Ag. Economics, Recreation and Parks, Ag. Engineering, and Entomology had significant increases in average enrollment per class. Average class size is the largest in Ag. Economics (over 69 students in period two) and is the smallest in Ag. Engineering (31 students in the first period). By far, most classes in COALS are three or more credits. Ag. Economics, Plant Pathology, and Entomology have seen decreases in the percentage of three or more credit classes. In Ag. Leadership, Recreation and Parks, Soil and Crops, and Ag. Engineering, percentages of classes with three or more credits increased between the two periods.

There are large variations in class sizes among the departments, and there is variability within a class by semester. Animal Science and Wildlife Management have a fairly stable number of students in classes, while others, such as Soil and Crops had increases in class size until the mid-2000s, but then show a decrease in numbers.

## 3.3 Instructor Characteristics

All departments have significant decreases in the percentage of male instructors in period two over period one, except Horticulture and Plant Pathology, which have significant increases. Ag. Leadership is the only department that had predominantly female instructors, but only in the second period (54 percent female instructors, note: the value reported in the table is percent male instructors). The percentage of male instructors is as large as 99 percent (in Entomology). Rank of instructors also varies among the different departments and periods, with no easily discernable pattern. In the first period, for example, almost 92 percent of all instructors in Entomology were professors, while in the same period in Ag. Leadership, only 19 percent of all instructors were professors. If significant, the percentage of instructors that graduated from non-AAU schools decreased between the two periods. The percentage of instructors graduating from a non-AAU school ranged from 51 percent (Horticulture and Biochemistry) to 84 percent (Ag. Engineering) in the first period, and from 35 percent (Entomology) to 71 percent (Wildlife Management) in the second period.

### 3.4 Student Characteristics

Compared to the previous two groups of characteristics, student characteristics have more similarities in direction and magnitudes among the departments. All departments had decreases in the percent of male students between the first and second period except Ag. Economics, which had no significant change. The percentages of male students, however, still show a wide range, from 40 percent in Horticulture to 80 percent in Ag. Engineering for the first period, and 32 percent in Animal Science to 78 percent in Ag. Engineering in the second period. Average SAT scores are significantly higher in all departments in the second period, except Ag. Leadership and Soil and Crops. SAT scores visibly drop in the last two semesters in almost all departments (Figure 2). The lower end of the range on average SAT scores changed little between the two periods, 526 (Poultry Science) and 528 (Ag. Leadership), whereas the upper end has increased from 603 to 624 (both in Biochemistry).

In six departments (Ag. Economics, Ag. Leadership, Ag. Engineering, Animal Science, Biochemistry, and Soil and Crops), average student load significantly decreased, and in three departments (Horticulture, Recreation and Parks, and Wildlife Management), load increased. Several conflicting policy changes may impact student load. The university gradually decreased the number of credits necessary to graduate from 140 to 120 between the mid-1980s and early 2000s. Currently, TAMU generally requires 120 credits to graduate. Any student taking more than 150 credits is required to pay out-of-state tuition. The number of credits a student can take before having to pay out-of-state tuition decreased between 1999 and 2006. Students graduating with 123 or less credits may be eligible for a small tuition rebate. In Fall 2005, TAMU changed tuition from per credit to a set rate for students taking twelve plus credits. TAMU introduced flat versus variable rate tuition in 2014 where students entering the university can select a tuition plan for the next four years.

Average high school rank is 73 percentile or higher in all departments, meaning that in high school 73 percent or more of all students ranked below those students accepted to COALS. Four departments (Ag. Economics, Ag. Leadership, Biochemistry, and Soil and Crops) had significant decreases in high school rank, whereas two departments (Animal Science and Entomology) show increases between the two periods. Other departments' groupings, which includes three STEM majors (Entomology, Ag. Engineering, and Biochemistry), showed students' high school rank increased in both time periods until the last couple of years. The share of no grade has either significantly decreased or has not changed between the two periods for all departments. Biochemistry (with more than 5 percent of students receiving no grades) had the largest percentage of no grades in both periods.

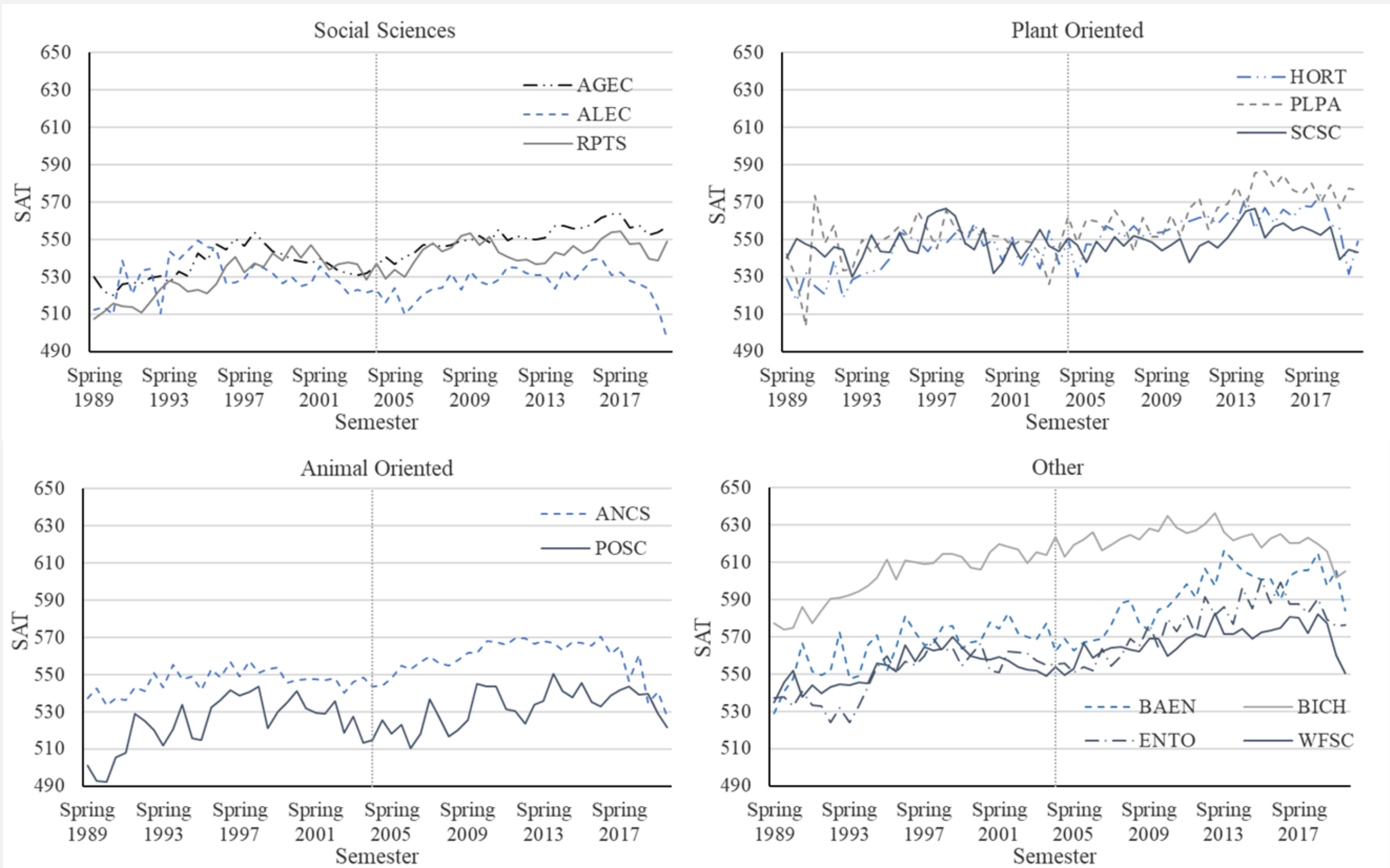


**Figure 2: College of Agriculture and Life Sciences Departments' Average SAT Scores by Semester from 1989 to 2019**

# 4 Model

Descriptive statistics show there are differences among departments within COALS. Furthermore, different instructors have different teaching styles and may grade differently, which may make the assumption of independence of observations invalid. To account for these differences, mixed effect models (Goldstein and Hoboken 2011) are estimated individually for each department. Previous studies have also used mixed effect models in examining grading patterns (Kokkelenberg, Dillon, and Christy 2008; Beenstock and Feldman 2016; Hernández-Julián and Looney 2016).

The mixed effect model estimated contains both fixed and random components along with two levels. The first level measures the fixed effect or within-individual variation and includes intercept and explanatory variables (institutional, instructor, and student-specific characteristics). The second level measures the random effect or the between individual variations for instructors, thus incorporating instructor-specific variability in estimation of the average grade in each class.

The Level 1 equation is:

$$y_{ij} = \beta_{0j} + \beta_1 x_{ij} + \varepsilon_{ij} \tag{1}$$

where $y_{ij}$ is the GPA for the $i^{\text{th}}$ class taught by the $j^{\text{th}}$ instructor, $x_{ij}$ is the vector of the $i^{\text{th}}$ class characteristic (institutional, instructor, and student-specific characteristics) for $j^{\text{th}}$ instructor, $\beta_{0j}$ represents fixed effects, or mean GPA for the $j^{\text{th}}$ instructor, $\beta_1$ is the vector of coefficients for class characteristics, and $\varepsilon_{ij}$ represents residuals for the $i^{\text{th}}$ class taught by the $j^{\text{th}}$ instructor. The Level 2 equation is:

$$\beta_{0j} = \gamma_{00} + u_{0j} \tag{2}$$

Where $\beta_{0j}$ is the fixed effect or mean GPA for the $j^{th}$ instructor, $\gamma_{00}$ is the fixed intercept across all groups, and $u_{0j}$ is the deviation of the $j^{th}$ instructor from the fixed intercept. The error terms are assumed to be distributed with mean zero and constant variance within a level, but the variance can differ between the levels.

# 5 Results

Given the number of models and variables, limited discussion is provided on inferences on the coefficients by department and period (Tables 3 and 4). As shown in the two tables, there are period and departmental differences in significances, signs, and magnitudes of some of the coefficients, but also many similarities.

## 5.1 Potential Grade Inflation

In the first period, one department (Poultry Science) has a significant and negative coefficient associated with trend, whereas four departments (Ag. Economics, Ag. Engineering, Animal Science, and Soil and Crops) have positive and significant coefficients associated with trend after controlling for the other characteristics. In the second period, the negative significant trend coefficient is observed in Biochemistry, while the number of departments with positive significant trend coefficients doubles (Ag. Economics, Ag. Leadership, Ag. Engineering, Horticulture, Plant Pathology, Poultry Science, Recreation and Parks, and Soil and Crops). It appears the increase in COALS grades reported by Yeritsyan, Mjelde, and Litzenberg (2022) for COALS as a whole is caused by most of the departments experiencing increasing trend in grades, especially in the second period, but not all departments.

## 5.2 Institutional Characteristics

Institutional characteristics appear to show few patterns concerning significance, signs, and magnitudes of the coefficients. Eleven of the 24 coefficients associated with morning classes are significant, and all but two are negative. Only in Plant Pathology (not significant), Soil and Crops, and Poultry Science are the sign and significance of this coefficient consistent between the two periods. Classes taught during morning hours (if significant) are correlated with lower GPAs than afternoon classes with the one exception, Biochemistry in the second period. This is in line with Marbouti et al.'s (2018) finding that early morning and late Friday afternoon classes attendance and grades are lower than other meeting times. Classes meeting only once a week generally are correlated with higher grades. In period one, 10 coefficients are significant and negative for meeting two or more times a week. Only one department, Ag. Economics, had a significant and positive coefficient for meeting two or more times a week. Differences between time periods are present. In period two, five coefficients are negative and significant when meeting more than once a week, and five coefficients are significant and positive when meeting more than once a week. For both periods, only Entomology and Recreation and Parks had no significant coefficients associated with the number of classes per week.

The number of students in the class is negatively correlated with grades for all departments and periods except for Recreation and Parks in period two where the coefficient is insignificant. This finding is in line with many studies who find students perform better in smaller class sizes (Nye, Hedges, and Konstantopoulos 2001; Kokkelenberg, Dillon, and Christy 2008; Diette and Raghav 2015). If significant,

**Table 3: Class GPAs Parameter Estimates using a Mixed Effect Model for Period 1 (Years 1989–2003)**

| | Social Sciences | | | Plant Oriented | | | Animal Oriented | | | Other | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Variable** | **AGEC** | **ALEC** | **RPTS** | **HORT** | **PLPA** | **SCSC** | **ANSC** | **POSC** | **BAEN** | **BICH** | **ENTO** | **WFSC** |
| Ln trend | 0.006* | -0.004 | -0.002 | 0.002 | -0.0003 | 0.005* | 0.005* | -0.012* | 0.008* | 0.001 | -0.001 | -0.002 |
| | (0.001) | (0.002) | (0.003) | (0.002) | (0.006) | (0.002) | (0.001) | (0.003) | (0.002) | (0.002) | (0.002) | (0.002) |
| **Institutional Variables** | | | | | | | | | | | | |
| Morning | -0.060* | -0.001 | -0.097* | 0.073* | -0.030 | -0.100* | -0.074* | -0.208* | -0.037 | 0.013 | -0.191* | -0.081 |
| | (0.020) | (0.030) | (0.037) | (0.031) | (0.110) | (0.050) | (0.025) | (0.057) | (0.038) | (0.022) | (0.063) | (0.045) |
| Meet 2 | 0.051* | -0.142* | -0.111 | -0.177 | -0.061 | -0.471 | -0.277* | -0.405* | -0.158* | -0.187* | -0.347 | 0.018 |
| | (0.024) | (0.034) | (0.084) | (0.140) | (0.118) | (0.286) | (0.033) | (0.199) | (0.048) | (0.058) | (0.251) | (0.154) |
| Meet 3 | n/a | -0.391* | -0.087 | -0.119 | -0.627* | -0.789* | -0.254* | -0.205 | -0.056 | -0.206* | -0.146 | 0.101 |
| | | (0.086) | (0.088) | (0.163) | (0.150) | (0.292) | (0.042) | (0.201) | (0.062) | (0.064) | (0.263) | (0.163) |
| Upper division | -0.005 | -0.017 | 0.111 | 0.018 | -0.205 | -0.223* | 0.146* | -0.102 | 0.134* | 0.108 | -0.131 | -0.054 |
| | (0.058) | (0.043) | (0.047) | (0.035) | (0.206) | (0.093) | (0.035) | (0.058) | (0.047) | (0.062) | (0.090) | (0.061) |
| Total students | -0.001* | -0.002* | -0.004* | -0.002* | -0.008* | -0.002* | -0.002* | -0.001* | -0.003* | -0.003* | -0.003* | -0.002* |
| | (0.0003) | (0.0003) | (0.001) | (0.0003) | (0.002) | (0.001) | (0.0002) | (0.001) | (0.001) | (0.0003) | (0.001) | (0.001) |
| High credit | n/a | -0.152* | -0.069 | -0.165 | -0.139 | 0.171 | -0.033 | -0.018 | -0.231* | -0.493* | -0.098 | -0.700* |
| | | (0.035) | (0.094) | (0.142) | (0.128) | (0.293) | (0.033) | (0.203) | (0.052) | (0.056) | (0.297) | (0.156) |
| **Instructor Variables** | | | | | | | | | | | | |
| Instructor gender | -0.0002 | -0.014 | -0.022 | -0.050 | -0.101 | -0.004 | -0.036 | -0.147 | 0.166 | 0.074 | xxx | -0.042 |
| | (0.134) | (0.055) | (0.092) | (0.066) | (0.090) | (0.163) | (0.067) | (0.140) | (0.157) | (0.072) | | (0.116) |
| Assistant prof | 0.050 | 0.060 | 0.081 | 0.006 | 0.036 | -0.263* | 0.069 | -0.099 | 0.001 | -0.008 | -0.287* | -0.046 |
| | (0.050) | (0.063) | (0.091) | (0.068) | (0.141) | (0.107) | (0.047) | (0.100) | (0.097) | (0.056) | (0.133) | (0.081) |
| Associate prof | 0.050 | -0.051 | 0.064 | -0.036 | 0.026 | 0.078 | 0.058 | 0.056 | -0.157 | -0.005 | -0.086 | 0.042 |
| | (0.037) | (0.049) | (0.078) | (0.050) | (0.115) | (0.059) | (0.033) | (0.074) | (0.086) | (0.039) | (0.102) | (0.056) |
| Lecturer graduate | -0.103 | 0.141* | 0.201 | 0.070 | -0.124 | -0.004 | 0.091 | 0.188 | -0.071 | -0.139 | xxx | 0.006 |
| | (0.778) | (0.068) | (0.114) | (0.076) | (0.146) | (0.150) | (0.059) | (0.117) | (0.192) | (0.097) | | (0.096) |

**Table 4 continued.**

| | Social Sciences | | | Plant Oriented | | | Animal Oriented | | | Other | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Variable** | **AGEC** | **ALEC** | **RPTS** | **HORT** | **PLPA** | **SCSC** | **ANSC** | **POSC** | **BAEN** | **BICH** | **ENTO** | **WFSC** |
| Other lecturer | -0.065 | -0.006 | 0.204 | 0.180 | xxx | 0.492* | 0.153 | 0.310 | -0.140 | -0.049 | n/a | 0.224 |
| | (0.136) | (0.090) | (0.130) | (0.114) | | (0.193) | (0.083) | (0.171) | (0.162) | (0.100) | | (0.149) |
| Non-AAU | 0.129* | -0.123* | 0.024 | 0.013 | 0.078 | -0.073 | -0.089 | 0.013 | 0.098 | -0.049 | -0.017 | -0.044 |
| | (0.064) | (0.054) | (0.098) | (0.058) | (0.135) | (0.121) | (0.064) | (0.094) | (0.112) | (0.062) | (0.105) | (0.088) |
| **Student Variables** | | | | | | | | | | | | |
| Student gender | -0.575* | -0.299* | -0.130 | -0.341* | -0.014 | 0.069 | -0.136* | 0.335* | -0.421* | -0.132 | -0.110 | -0.236* |
| | (0.100) | (0.112) | (0.147) | (0.087) | (0.236) | (0.114) | (0.067) | (0.172) | (0.112) | (0.080) | (0.114) | (0.107) |
| SAT | 0.003* | 0.003* | -0.0003 | 0.002* | 0.0005 | 0.001 | 0.002* | 0.001 | 0.001 | 0.005* | 0.003* | -0.0001 |
| | (0.001) | (0.001) | (0.001) | (0.0004) | (0.001) | (0.001) | (0.0004) | (0.001) | (0.001) | (0.0004) | (0.001) | (0.001) |
| Student load | 0.037* | 0.009 | -0.022 | 0.001 | -0.090 | 0.040 | 0.035* | -0.062* | 0.007 | 0.039* | 0.039* | 0.026 |
| | (0.018) | (0.016) | (0.019) | (0.013) | (0.050) | (0.024) | (0.112) | (0.020) | (0.018) | (0.017) | (0.016) | (0.024) |
| HS percentile | 0.005* | 0.003 | -0.001 | 0.002 | 0.008* | 0.001 | 0.008* | 0.007* | 0.006* | 0.006* | 0.006* | 0.003 |
| | (0.001) | (0.002) | (0.002) | (0.002) | (0.004) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.003) |
| Share no grade | -1.317* | -1.314* | -2.526* | -0.558* | -0.411 | -1.031* | -0.808* | -1.963* | -1.602* | -0.695* | -0.104 | -0.884* |
| | (0.212) | (0.354) | (0.358) | (0.261) | (0.613) | (0.270) | (0.239) | (0.546) | (0.383) | (0.174) | (0.405) | (0.296) |
| **Random-Effect Parameters** | | | | | | | | | | | | |
| Instructor | 0.569* | 0.016* | 0.073* | 0.029* | 0.041* | 0.089* | 0.045* | 0.020* | 0.066* | 0.071* | 0.050* | 0.049* |
| Residual | 0.048* | 0.043* | 0.107* | 0.056* | 0.075* | 0.076* | 0.055* | 0.082* | 0.072* | 0.053* | 0.054* | 0.076* |

*Note*:* denotes statistical significance at 0.05 or lower ($p$ value < 0.05). Standard errors in parentheses below the estimated coefficients. When the number of observations is fewer than five observations (marked as xxx), the variable is removed for confidentiality reasons and because conclusions drawn would be suspect. See text for definitions of department acronyms.

**Table 4: Class GPAs Parameter Estimates using a Mixed Effect Model for Period 2 (Years 2004–2019)**

| | Social Sciences | | | Plant Oriented | | | Animal Oriented | | | Other | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Variable** | **AGEC** | **ALEC** | **RPTS** | **HORT** | **PLPA** | **SCSC** | **ANSC** | **POSC** | **BAEN** | **BICH** | **ENTO** | **WFSC** |
| Ln trend | 0.006* | 0.005* | 0.004* | 0.006* | 0.008* | 0.006* | 0.001 | 0.008* | 0.005* | -0.004* | 0.005 | -0.001 |
| | (0.001) | (0.002) | (0.002) | (0.002) | (0.003) | (0.002) | (0.001) | (0.003) | (0.002) | (0.001) | (0.003) | (0.002) |
| **InstitutionalVariables** | | | | | | | | | | | | |
| Morning | -0.010 | -0.054* | -0.034 | -0.001 | -0.025 | -0.167* | -0.011 | -0.200* | 0.024 | 0.065* | -0.002 | 0.032 |
| | (0.020) | (0.019) | (0.026) | (0.026) | (0.055) | (0.046) | (0.020) | (0.041) | (0.037) | (0.024) | (0.037) | (0.038) |
| Meet 2 | 0.113* | 0.073* | -0.051 | 0.152* | -0.142 | 0.215* | 0.016 | -0.369* | -0.103 | -0.273* | 0.027 | -0.142* |
| | (0.058) | (0.024) | (0.072) | (0.047) | (0.091) | (0.073) | (0.026) | (0.069) | (0.059) | (0.033) | (0.071) | (0.055) |
| Meet 3 | 0.109 | 0.075* | -0.031 | 0.154 | -0.077 | 0.132 | -0.029 | -0.202* | -0.114 | -0.295* | 0.103 | 0.045 |
| | (0.060) | (0.031) | (0.075) | (0.088) | (0.122) | (0.077) | (0.033) | (0.082) | (0.067) | (0.042) | (0.081) | (0.094) |
| Upper division | 0.076 | 0.044 | -0.030 | -0.019 | -0.123 | -0.172* | 0.175* | -0.068 | 0.005 | -0.091 | 0.187* | -0.264* |
| | (0.044) | (0.033) | (0.041) | (0.040) | (0.076) | (0.071) | (0.027) | (0.058) | (0.055) | (0.057) | (0.054) | (0.071) |
| Total students | -0.001* | -0.002* | -0.001 | -0.002* | -0.003* | -0.001* | -0.001* | -0.002* | -0.006* | -0.001* | -0.001* | -0.004* |
| | (0.0002) | (0.0004) | (0.001) | (0.0002) | (0.001) | (0.0005) | (0.0001) | (0.001) | (0.001) | (0.0003) | (0.0004) | (0.001) |
| High credit | -0.478* | -0.251* | -0.187* | -0.382* | -0.399* | -0.352* | -0.228* | 0.003 | -0.406* | -0.286* | -0.219* | -0.352* |
| | (0.084) | (0.025) | (0.088) | (0.051) | (0.080) | (0.071) | (0.025) | (0.071) | (0.062) | (0.036) | (0.076) | (0.062) |
| **Instructor Variables** | | | | | | | | | | | | |
| Instructor gender | -0.096 | 0.126* | -0.190* | 0.009 | -0.079 | 0.187 | -0.094 | -0.096 | -0.061 | -0.081 | -0.083 | -0.171 |
| | (0.096) | (0.058) | (0.076) | (0.112) | (0.079) | (0.144) | (0.060) | (0.165) | (0.095) | (0.082) | (0.150) | (0.133) |
| Assistant prof | 0.106 | 0.071 | 0.034 | -0.017 | 0.247* | 0.166 | -0.021 | 0.063 | 0.037 | -0.089 | -0.122 | -0.068 |
| | (0.064) | (0.059) | (0.073) | (0.095) | (0.085) | (0.096) | (0.049) | (0.078) | (0.083) | (0.056) | (0.086) | (0.085) |
| Associate prof | 0.041 | 0.006 | -0.035 | -0.001 | 0.063 | 0.142 | 0.002 | -0.042 | 0.024 | -0.043 | -0.167* | -0.106 |
| | (0.047) | (0.052) | (0.055) | (0.060) | (0.066) | (0.091) | (0.033) | (0.064) | (0.066) | (0.048) | (0.071) | (0.068) |
| Lecturer graduate | 0.065 | 0.120 | 0.073 | 0.223 | n/a | xxx | 0.137* | - 0.063 | -0.198 | -0.150 | -0.036 | 0.050 |
| | (0.074) | (0.073) | (0.088) | (0.139) | | | (0.065) | (0.099) | (0.153) | (0.126) | (0.185) | (0.128) |
| Other lecturer | 0.107 | 0.121 | 0.247* | 0.080 | 0.132 | 0.481* | 0.167 | 0.132 | -0.123 | 0.005 | 0.098 | -0.165 |
| | (0.072) | (0.080) | (0.102) | (0.129) | (0.220) | (0.213) | (0.091) | (0.222) | (0.116) | (0.108) | (0.176) | (0.157) |

**Table 4 continued.**

| | Social Sciences | | | Plant Oriented | | | Animal Oriented | | | Other | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Variable** | **AGEC** | **ALEC** | **RPTS** | **HORT** | **PLPA** | **SCSC** | **ANSC** | **POSC** | **BAEN** | **BICH** | **ENTO** | **WFSC** |
| Non-AAU | -0.023 | -0.058 | 0.057 | 0.139 | -0.033 | -0.136 | -0.069 | -0.085 | 0.087 | -0.037 | 0.078 | -0.122 |
| | (0.047) | (0.037) | (0.064) | (0.091) | (0.094) | (0.087) | (0.042) | (0.111) | (0.069) | (0.046) | (0.113) | (0.082) |
| **Student Variables** | | | | | | | | | | | | |
| Student gender | -0.296* | -0.434 | -0.265* | -0.053 | -0.364* | -0.438* | -0.245* | 0.050 | -0.329* | -0.148* | -0.043 | -0.493* |
| | (0.095) | (0.070) | (0.095) | (0.092) | (0.154) | (0.116) | (0.067) | (0.128) | (0.109) | (0.072) | (0.132) | (0.101) |
| SAT | 0.003* | 0.001* | -0.0005 | 0.001* | 0.001 | 0.001 | 0.002* | -0.0003 | 0.001* | 0.004* | 0.004* | -0.0004 |
| | (0.001) | (0.0004) | (0.001) | (0.001) | (0.001) | (0.001) | (0.0003) | (0.001) | (0.001) | (0.0004) | (0.001) | (0.001) |
| Student load | -0.018 | 0.023 | 0.028 | 0.004 | -0.043 | 0.015 | 0.005 | 0.010 | -0.090* | -0.015 | 0.051* | 0.005 |
| | (0.016) | (0.013) | (0.017) | (0.017) | (0.027) | (0.020) | (0.012) | (0.026) | (0.020) | (0.013) | (0.022) | (0.018) |
| HS percentile | 0.005* | 0.005* | 0.001 | 0.008* | 0.008* | 0.001 | 0.007* | 0.007* | 0.009* | 0.015* | 0.007* | 0.004 |
| | (0.002) | (0.001) | (0.017) | (0.002) | (0.003) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.003) | (0.018) |
| Share no grade | -1.986* | -2.081* | -0.054 | -0.677* | -1.825* | -0.317 | -1.106* | -0.279* | -1.110* | -0.842* | -0.977* | -0.891* |
| | (0.271) | (0.248) | (0.108) | (0.192) | (0.564) | (0.299) | (0.192) | (0.331) | (0.389) | (0.148) | (0.359) | (0.291) |
| **Random-Effect Parameters** | | | | | | | | | | | | |
| Instructor | 0.060* | 0.058* | 0.095* | 0.068* | 0.032* | 0.125* | 0.041* | 0.087* | 0.085* | 0.085* | 0.086* | 0.097* |
| Residual | 0.049* | 0.067* | 0.061* | 0.064* | 0.068* | 0.071* | 0.064* | 0.058* | 0.087* | 0.069* | 0.093* | 0.072* |

*Note*:* denotes statistical significance at 0.05 or lower ($p$ value < 0.05). Standard errors in parentheses below the estimated coefficients. When the number of observations is fewer than five observations (marked as xxx), the variable is removed for confidentiality reasons and because conclusions drawn would be suspect. See text for definitions of department acronyms.

courses with three or more credits are correlated with lower grades relative to courses with one or two credits.

## 5.3 Instructors' Characteristics

Of the 138 coefficients (six are not considered because they are drawn on a small number of observations) associated with instructor characteristics, only thirteen are significant (six in the first and seven in the second period). In an ideal world, none of the variables in this group would correlate with grades. Only in Soil and Crop Sciences is the coefficient associated with other instructors significant in both periods. In the second period, instructors' gender is significantly correlated with grades in Recreation and Parks (males grading lower than females) and in Ag. Leadership (females grading lower than males). Assistant professors are significantly correlated with lower grades than professors in Soil and Crops and Entomology in the first period. In Plant Pathology for the second period, assistant professors are significantly correlated with higher grades than professors. Associate professors are significantly correlated with lower grades than professors only in Entomology in the second period. Graduating from an AAU or non-AAU school appears to have little to no correlations with grades, especially in the second period. If significant, graduate students and other lecturers' coefficients are positive, indicating higher grades than professors, but this occurs in only a few cases (period one Ag. Leadership and Soil and Crops; period two Recreation and Parks, Soil and Crops, and Animal Science). Research suggests that one of the reasons for higher grades granted by visiting and adjunct faculty could be the expectation of higher student evaluations (Sonner 2000; Kezim, Pariseau, and Quinn 2005). These instructors are often hired on the term-by-term basis, and higher student evaluations are more likely to result in their contract being extended. But this does not seem to be the general case in COALS.

## 5.4 Students' Characteristics

Students' characteristics have more significant coefficients compared to instructors' characteristics. If significant, students' characteristics generally have similar inferences in all departments: a decrease in the percentage of male students, as well as increases in SAT score and high school rank, have positive correlations with GPA, while an increase in the share of students with no grades has a negative correlation with GPA. Studies such as Voyer and Voyer (2014) and O'Dea et al. (2018) also find females tend to receive higher grades. In two of the four departments where student gender is insignificant in the second period, the percentage of female students is larger than males (Ag. Leadership and Horticulture).

In five departments (Recreation and Parks, Plant Pathology, Poultry Science, Soil and Crops, and Wildlife Management) for both periods, increasing SAT scores are not significantly correlated with increasing GPAs. Although you would expect SATs to reflect students' ability, studies such as Haladyna, Nolen, and Haas (1991) and Reames and Bradshaw (2009) support the idea that SAT scores have increased over time without a corresponding increase in student educational achievement. They claim this may be a result of public schools preparing students to take standardized tests. High school rank, reflecting student preparedness and motivation (Westrick et al. 2015), is insignificant in five departments in the first period (Ag. Leadership, Horticulture, Recreation and Parks, Soil and Crops, and Wildlife Management), but is only insignificant in three departments in the second period (Recreation and Parks, Soil and Crops, and Wildlife Management). As expected, the percentage of students receiving a no grade is generally correlated with lower class GPAs. Barker and Pomerantz (2000) state dropping a course may suggest poor performance and indicate responsible behavior by students who are considering their academic futures. Five coefficients are significant and positive, and two are significant and negative for student load considering both periods. These findings weakly suggest motivated students and students with less free time do not procrastinate and organize their time more wisely, resulting in better study habits leading to higher grades. The changes previously discussed that may influence student load may be leading to this characteristic being insignificant in many departments.

# 6 Conclusions and Discussions

Differences in class average GPAs for periods 1989–2004 and 1989–2019 among twelve departments within COALS at TAMU are examined through addressing two objectives.

*Objective 1. To determine if potential grade inflation has been occurring by department and if it differs over time.*

A significant and positive coefficient for trend indicates potential grade inflation, but it must be noted missing variables may be contributing to the trend coefficient. Potential grade inflation occurred in four departments in the first period (1989–2003). In the second period (2004–2019), the number of departments experiencing potential grade inflation doubled to eight out of the twelve departments. Three departments, Ag. Economics, Ag. Engineering, and Soil and Crops had potential grade inflation in both periods. In contrast, in each period, only one department had potential grade deflation (Poultry Science in period one and Biochemistry in period two). Poultry Science experienced grade decreases in the first period and increases in the second period.

Although not in the model, the change in the number of departments experiencing potential grade inflation roughly corresponds to factors previous studies suggest as reasons for grade inflation, including tuition and fee increases, increase in the use of teaching evaluations, and student generation. The second period roughly corresponds to the time when Generation X were ending their student careers and millennials attended college. By the end of period two, Generation Z started to enroll in college. Howe and Strauss (2000) mention millennials were raised by their parents to succeed. In addition, Curran and Hill's (2019) meta-analysis shows recent generations of college students feel more pressure to excel than students in the 1990s. This need to excel could be one driving force behind students' complaints on grading and could foster grade inflation. Additional research on impacts of generation cohorts on grading patterns is warranted.

Grades show a decline in both Ag. Leadership and Ag. Engineering around 2006; however, grades crawl back up by the end of the second period. Discussion with the Ag. Engineering former department head indicated an attempt to increase rigor in their department. These observations imply grades are hard to reduce and/or maintain at lower levels.

The second objective is:

*Objective 2. Examine factors influencing mean class GPA among different departments in COALS to provide information on factors correlated with these differences and explore if the correlations have changed over time.*

Results show that there are differences in grading patterns among departments in COALS and even within the same department between time periods. It appears differences in GPAs are mainly driven by specifics of each department. This is in line with Yeritsyan, Mjelde, and Litzenberg (2022), who find significant departmental differences. Departmental culture, subject matter, job market prospects, and student expectations may be some of the reasons for departmental differences. These differences may manifest themselves in the magnitude of the coefficients differing although sign and significance are the same. Although departmental differences may be the main driving force, some differences are noted and discussed. Furthermore, because of these differences, one must be careful in comparing students and their GPAs between majors—an unfortunate inference for employers and graduate school recruiters.

In terms of ranking from the largest to smallest GPA between periods, only three departments had a change of more than two places in its ranking. Ag. Engineering changed from fourth to seventh in its ranking. As noted earlier, Ag. Engineering made a conscious attempt to add rigor to their program. No reason is found for the other two departments' change in ranking. Wildlife Management went from seventh to twelfth, with a significant decrease in GPA between periods. Plant Pathology, with the largest increase in GPA between periods, went from tenth to sixth. The remaining discussion concentrates on period two; as noted earlier, this may be the most relevant period.

Weak evidence exists that supports previous studies' claims that differences exist between STEM and non-STEM-designated departments. Seven of the eight non-STEM departments experienced potential grade inflation while two (Plant Pathology and Ag. Engineering) of the four STEM-designated departments (Ag. Engineering, Biochemistry, Entomology, and Plant Pathology) experienced potential grade inflation. As noted earlier, changes in Ag. Engineering grading may have more to do with changes in the departmental policies than STEM designation. One STEM department (Biochemistry) shows grade deflation and one no change (Entomology) in GPA. Over time, grade dispersion among all departments reduced from a GPA range of 2.72–3.50 in 1989 to 3.05–3.52 in 2019, making it more difficult to differentiate students' abilities.

Issues remain on why are there differences between departments. Discussions with departments indicated no clear departmental grading policies, and differences are mostly the result of subject matter differences. After controlling for instructors, characteristics associated with instructors are generally insignificant, implying these characteristics are not the reason for differences. Signs and significance of student characteristics are similar among departments, but magnitudes vary. Simple correlation between estimated coefficients on high school rank for twelve departments and average high school rank in those departments is 0.75. Such a moderate to strong correlation indicates the effect of preparation as given by high school rank is stronger in classes that have a higher average rank than classes with lower average rank. Correlations between the absolute value of the estimated coefficients and average values for student gender (0.38) and SAT scores (0.42) show weak-to-moderate relationships. Although the effect of students' characteristics such as preparedness, motivation, and gender are similar, having a larger percentage of better-prepared students, for example, has a larger impact (magnitude) on grades. More research is warranted on these relationships.

Institutional characteristics do not present as clear of a picture. Characteristics other than total students enrolled in a class and high credit show no consistent patterns. Correlation between estimated coefficients and the average number of high credit classes is very weak to nonexistent, at -0.16. Negative correlation between estimated coefficients and average number of students in a class shows an inverse, moderate to significant relationship (-0.68). Although increasing the number of students decreases grades, it appears at some point adding additional students has less of an effect. This indicates the relationship between the number of students and grades may be nonlinear. At some point, increasing the number of students may have little to no effect on class GPA. Again, more research is necessary on this relationship.

Questions not addressed include: (1) should grade reform be undertaken and (2) are departments willing to consider grading reform? These are complex, difficult questions involving issues such as enrollment, finance, and employment. Because administrators may not have a lot of control over individual instructors' grading standards, they may introduce the idea of "individual gain" (McGowen and Davis 2022). Individual gain is a numeric value calculated based on the initial test and a final test at the end of the class that can be used to complement grades on students' transcripts. Such a numeric value, however, would be a confusing addition to transcripts, especially until all universities adopt the idea.

Denning et al. (2022) show grade inflation has led to an increase in college graduation rates, one goal of accountability and proposed policy changes. Compared to education expenditures, grade inflation may be a low-cost policy option to ensure higher graduation rates and earlier graduation. However, the long-term consequences of such a policy, such as decline in quality of college graduates or university image deterioration needs to be considered. Future research should calculate the costs and benefits that come with increasing grades. Benefits comprise higher rates of completing college, which results in graduates who compete for better employment opportunities. Costs include lower preparedness of those graduates.

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