

Factors Influencing Students' Motivation and Performance in College Statistics Courses

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Background

“ Why do students frequently view statistics as the worst course taken in college? ”

- Robert V. Hogg (professor emeritus of statistics at the University of Iowa)

- Exploration of the various contributors to students' engagement and success for an introductory college statistics course and a second-level statistics course
- Recently developed survey was first administered to the University of Northern Colorado's (UNC) 54 intro-level statistics students in Fall 2021
- I implement the same survey tool on the College of Wooster's 46 200-level statistics students and compare data findings between the two cohorts
- I measure performance using students' first exam grades

Methods

- Component Scores are calculated as follows:

$$\frac{1}{n} \sum_{i=1}^n x_i,$$

where n is the number of survey items per component and x_i is the numerical response value corresponding to the 5-point Likert scale for each item.

- Obtaining the Proportional Odds Ordinal Logistic Regression Model:

Let Y be a discrete outcome variable with C ordered categories. The probability that Y is less than or equal to the value of a particular category C_i is written as

$$P(Y \leq C_i).$$

The odds of Y being less than or equal to a specific C_i is

$$\frac{P(Y \leq C_i)}{P(Y > C_i)},$$

for $1 \leq C_i \leq C - 1$.

Notice that $k = \frac{a}{b}$ is non-linear for all $b \neq 0$ but $k = \ln\left(\frac{a}{b}\right)$ is linear for all $a \neq 0$ and $b \neq 0$.

Thus, we compute the natural logarithm of the odds of Y being less than or equal to a specific C_i , which is given by

$$\ln\left(\frac{P(Y \leq C_i)}{P(Y > C_i)}\right).$$

Then, we can apply the formula from multiple linear regression to obtain

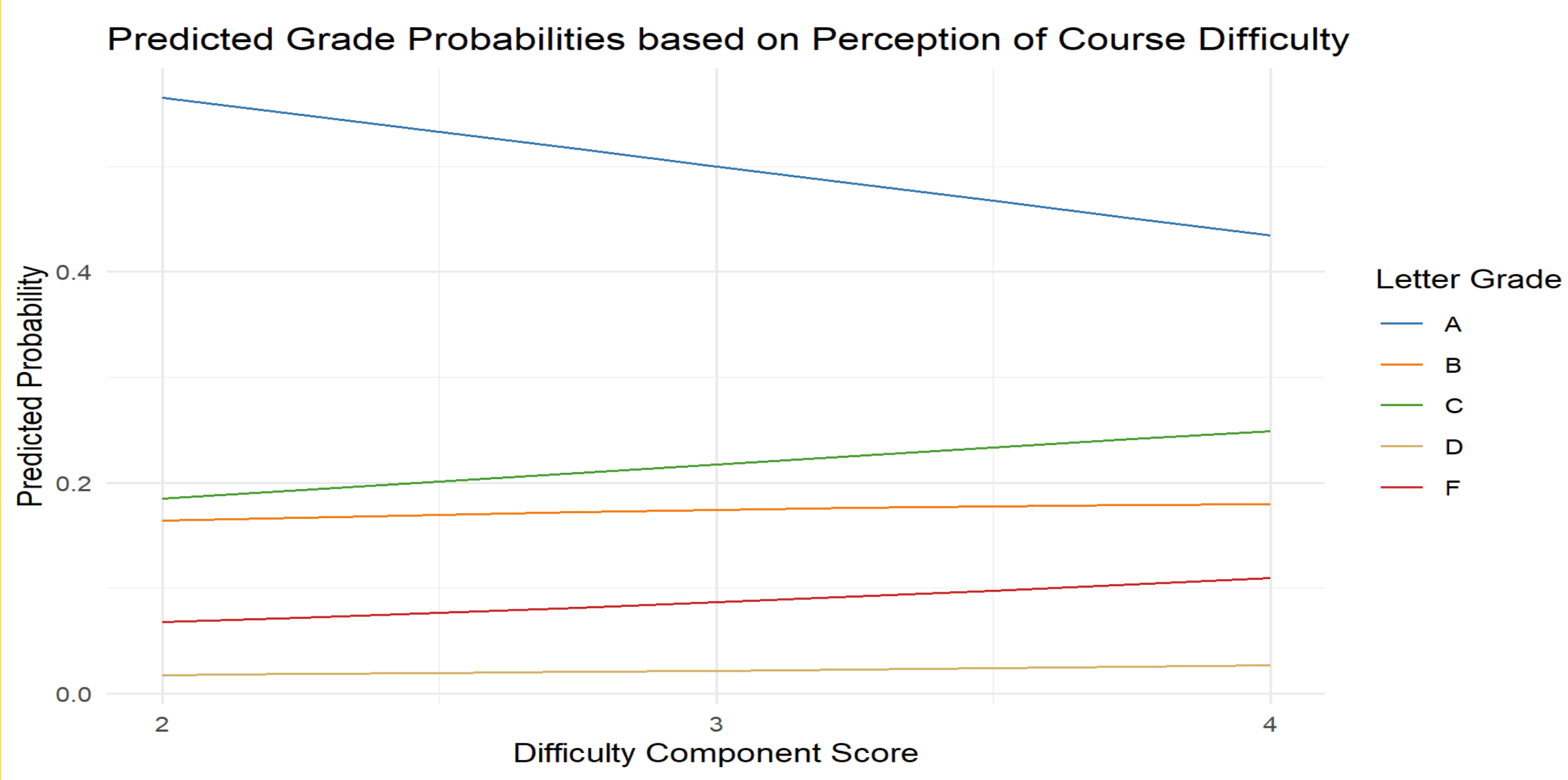
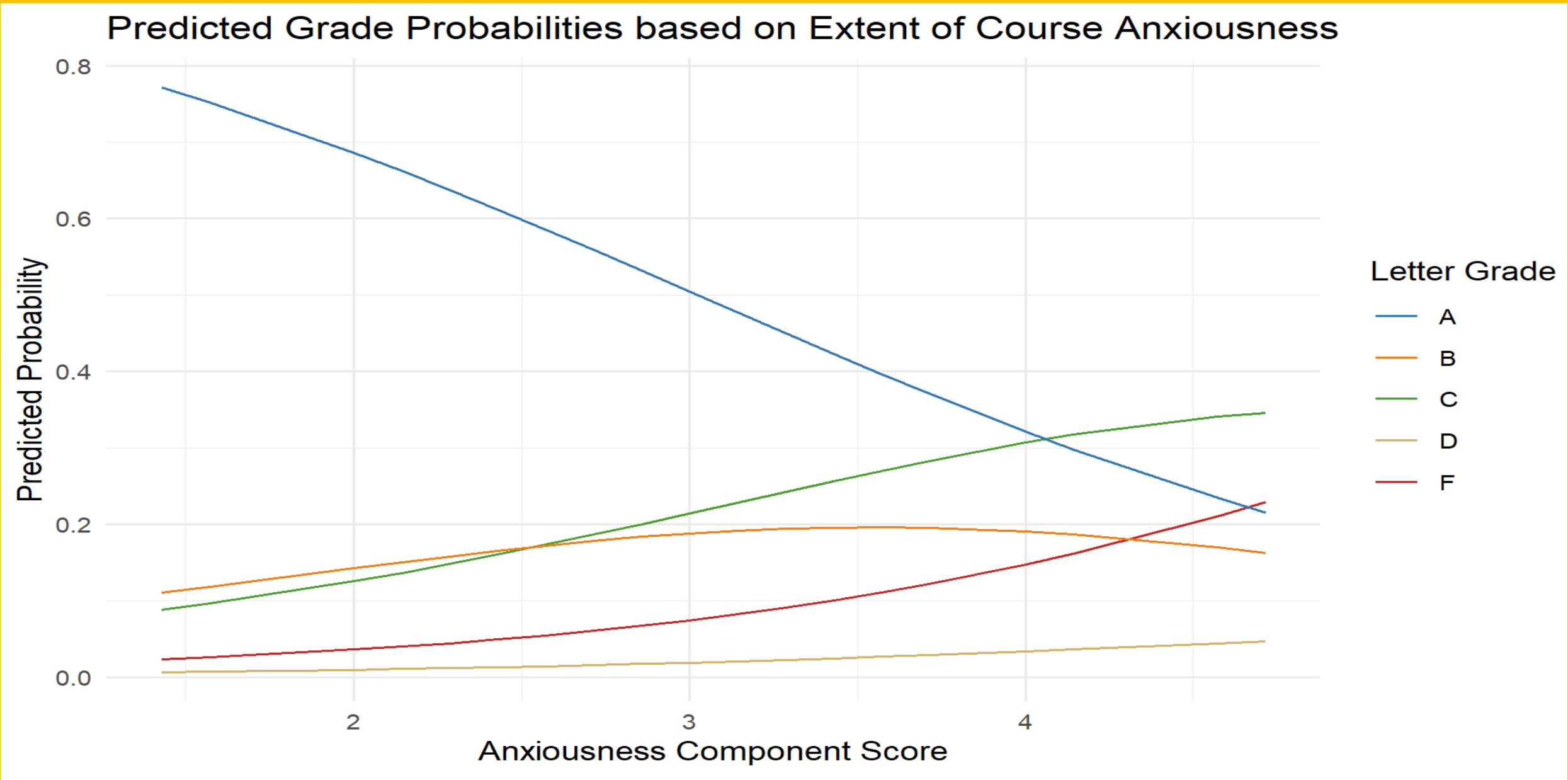
$$\ln\left(\frac{P(Y \leq C_i)}{P(Y > C_i)}\right) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \dots + \beta_n x_n,$$

the proportional odds ordinal logistic regression formula for n independent variables.

- Other methods used: Correlation Analysis, Linear Regression, Chi-Square Independence Tests, Cramer's V

Regression and Survey Reliability Results

- Ordinal logistic regression reveals that course anxiousness strongly predicts exam grades in both classes ($p < .05$ for both), while all other factors are somewhat or much weaker at predicting exam grades



- Cronbach's alpha analysis shows that UNC students' responses to items in each component are more consistent than that of Wooster's, despite strong item associations for all but the Difficulty component in both datasets

	UNC		Wooster	
Component	α Value	Bootstrapped 95% CI	α Value	Bootstrapped 95% CI
Anxiousness	0.845	(0.774, 0.896)	0.835	(0.732, 0.896)
Attitude	0.908	(0.856, 0.939)	0.859	(0.709, 0.919)
Difficulty	0.636	(0.434, 0.757)	0.456	(0.113, 0.644)
Professor	0.889	(0.811, 0.929)	0.859	(0.765, 0.911)

References

Cande V Ananth and David G Kleinbaum. "Regression models for ordinal responses: a review of methods and applications." In: International journal of epidemiology 26.6 (1997), pp. 1323–1333

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Survey Items and Effect on Grade

- Formatting: Statement/Question (UNC Residual Deviance, Wooster Residual Deviance)
- Highlights indicate effect size measurement (green = strongest association, blue = weakest associations)
- Course Anxiousness - students' feelings and emotions pertaining to their statistics course**
1. "Studying for an exam in a statistics course makes me anxious." (91.315, 109.667)
 2. "It makes me anxious to ask my statistics teacher for help with material I am having difficulty understanding." (95.456, 115.404)
 3. "Doing the coursework for a statistics course makes me anxious." (88.706, 115.070)
 4. "Taking an examination in a statistics course makes me anxious." (91.964, 108.378)
 5. "Walking into the room to take a statistics test makes me anxious." (85.356, 111.059)
 6. "Waking up in the morning on the day of a statistics test makes me anxious." (88.527, 110.112)
 7. "Enrolling in a statistics course makes me anxious." (87.653, 103.068)



- Attitudes toward Statistics - students' mindset towards the subject of statistics**
1. "I know I'll have problems getting through statistics." (88.584, 105.797)
 2. "I wonder why I have to do all these things in statistics when in actual life I'll never use them." (94.800, 115.713)
 3. "Statistics is worthless to me." (93.354, 116.178)
 4. "Statistics takes more time than it's worth." (95.369, 111.700)
 5. "I can't even understand secondary school math; how can I possibly do statistics?" (92.590, 116.166)
 6. "I lived this long without knowing statistics, why should I learn it now?" (93.525, 116.347)
 7. "Since I've never enjoyed math, I don't see how I can enjoy statistics." (95.610, 110.945)
 8. "I don't want to learn to like statistics." (96.442, 115.726)
 9. "Statistics is for people who have a natural leaning toward math." (94.597, 112.362)
 10. "Statistics is a pain I could do without." (90.395, 117.355)
 11. "I don't have enough brains to get through statistics." (92.796, 115.514)
 12. "I wish the statistics requirement would be removed from my academic program." (90.726, 115.575)
 13. "I can't tell you why, but I just don't like statistics." (87.025, 113.716)



- Course Difficulty - students' ratings of the difficulty and length of formative and summative assessments**
1. "Rate the difficulty level of your first exam." (82.522, 101.530)
 2. "Rate the length of your first exam." (91.599, 103.398)
 3. "Rate the difficulty level of your homework/assignments." (78.431, 110.831)
 4. "Rate the length of your homework/assignments." (94.266, 110.151)



- Course Professor - students' perceptions about their statistics professor**
1. "My instructor is very helpful inside of the classroom." (94.357, 116.628)
 2. "My instructor is very helpful outside of the classroom." (93.352, 116.464)
 3. "My instructor is readily available for additional help after class." (92.862, 107.842)
 4. "My instructor is readily available for additional help during office hours." (94.846, 115.554)
 5. "My instructor is approachable, nice and easy to communicate with." (92.415, 113.730)



- Additional item: Interest in Statistics**
1. "I feel very interested in learning and using statistics." (90.924, 117.582)

- Additional item: Statistics Experience before College**
1. Did you take any statistics course before college? (96.791, 117.519)

Key Takeaways and Implementations

- No discernible difference in the extent of statistics course anxiousness between 200-level students and the introductory students
- For both groups of students, course anxiousness (-) influences exam performance much more than subject attitudes, professor perception, and difficulty perception
 - Addressing and working to reduce students' course anxiousness should be an area of major focus for statistics educators, beginning early on in a course
- Even at the 200-level, exam-related stress is prevalent, and students' responses to items on this topic are significant contributors to exam grade
 - Educators should attempt to alleviate worries before an upcoming exam by discussing study strategies and holding review sessions
- In both groups, ratings of professors' availability for help after class (+) and approachability (+) strongly predict exam grade
 - Educators should make every effort to address students' questions/concerns in a timely manner before leaving class
- Students' interest in using statistics outside of class strongly relates to the level of course anxiousness (-), attitudes toward statistics (-), perceived course difficulty (+), and professor perceptions (+) at the intro level but only attitudes toward statistics (-) at the 200-level
 - Educators should provide more incentives for students at all levels to apply course content outside of class