

# Feel the fear and do it anyway: Statistics anxiety and perceived gains in a project-based statistics course

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## Statistical anxiety

Students may enter introductory statistics courses with anxiety towards statistics, low math and coding self-efficacy, and low intentions to use statistics in the future.

Past research found the project-based introductory statistics course attracts under-represented students who may not otherwise take statistics courses and improves their interest in further statistics courses.

This paper evaluated whether a project-based introductory statistics course was successful with students irrespective of their pre-course statistical anxiety and statistical intentions.

## Course description

Students were enrolled in project-based statistics at 28 universities in numerous departments: public health, statistics, psychology, sociology.

Despite heterogeneity, all students complete an individual research project using the analysis of real data using a statistical package.

Online textbook: 32 page PDF with professionally produced videos funded by National Science Foundation

Statistics packages: Stata, R, SAS, SPSS, StatCrunch

Example datasets: Add Health, Youth Risk Behavior Survey, Behavioral Risk Factor Surveillance System, National Epidemiologic Survey on Alcohol and Related Conditions.

Materials available at <http://passiondrivenstatistics.com/>

## Settings

We describe a project-based introductory statistics course taught in 28 courses at 28 universities (n=801) between Fall 2018 and Winter 2020



11 private liberal arts colleges, 3 flagship state universities, 12 regional city or state universities, and 2 community colleges, located in the United States.

## Data

Students took self-administered web surveys at the start and end of each semester.

The full data comprised 801 students from 28 classes.

Missing data were due to item non-response, so we used multiple imputation with 35 imputations in a multivariate normal model using pre-course demographics, socioeconomic status, and educational backgrounds.

## Measures

Statistics anxiety: "Do you agree with the following statement? The thought of being enrolled in a statistics course makes me nervous."

Statistics intentions: count of intended future uses of statistics (range 0-6)

Perceived gains were measured by z-scores of 5 subscales of the Undergraduate Research Student Self-Assessment

- Thinking like a scientist
- Personal gains
- Skill gains
- Scientific engagement
- Future preparation.

These data were designated exempt per 45 CFR 46.104(d)(2) as research that only involves the use of educational tests, surveys, interviews, or observations of public behavior by Wesleyan University's Institutional Review Board (Project ID 20190701).

## Abstract

The Passion-Driven Statistics curriculum teaches students to apply introductory statistics concepts to complete an independent project using real datasets using R, SAS, Stata, SPSS, or Python. Participants will learn about the project-based curriculum, which comprises a free 32-page e-book, professionally produced YouTube videos, and Slack forums for instructors and students. Undergraduate and graduate students in community colleges, flagship and regional universities, and small liberal arts colleges have used this curriculum, and past research has found success with students who might not otherwise enroll in quantitative courses. In this study, we evaluated whether students' pre-course attitudes were associated with perceived gains among 801 students attending 28 private and public universities, fall 2018 - January 2020. We used multilevel mixed-effects linear regression within multiply imputed data. Each increment of future intentions to use statistics (range 0-6) was associated with 0.09-0.17 standard deviations of greater gains on all subscales of the Undergraduate Research Student Self-Assessment: perceived future preparation, skill gains, thinking like a scientist, scientific engagement, and personal gains. Binary measures of low math confidence and statistics anxiety were not associated with perceived gains. Project-based courses can be effective with students who enter the course with intentions of using statistics, despite statistics anxiety.

## Pre-course math and coding confidence

Pre-course: 44.2% reported feeling nervous about taking statistics at the start of the course.

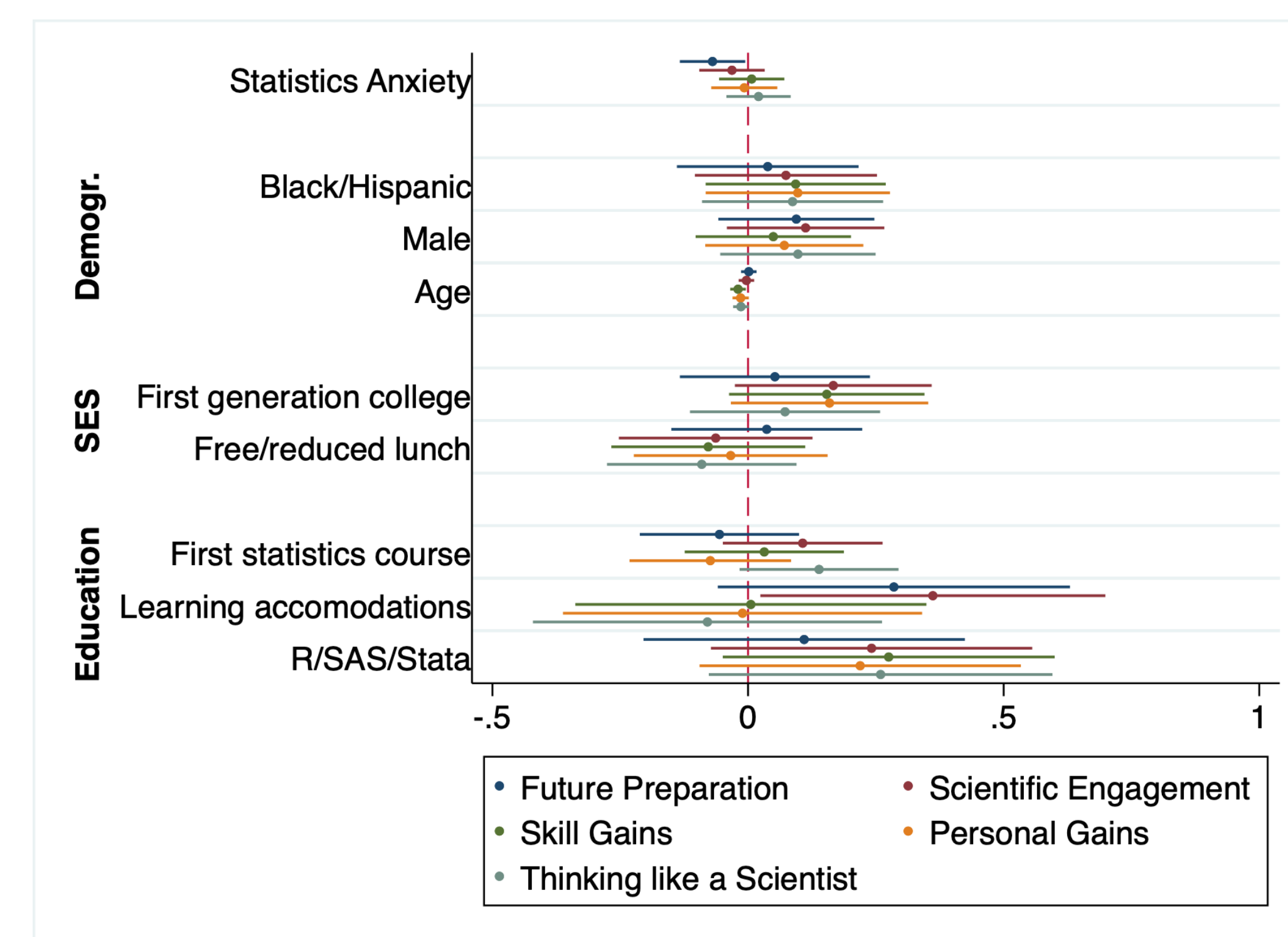
Statistics anxiety was less common among male students and more common among students from low SES backgrounds, without prior statistics courses, and taking courses using R, SAS, or Stata (vs. SPSS or StatCrunch).

|                         | Statistics Anxiety Intentions |   |
|-------------------------|-------------------------------|---|
| Black/Hispanic          | -                             | + |
| Male                    | -                             | + |
| First gen.              | -                             | + |
| Age in years            | -                             | + |
| Free/reduced lunch      | +                             | - |
| First statistics course | +                             | - |
| Learning accommodations | -                             | + |
| Course uses R/SAS/Stata | -                             | + |

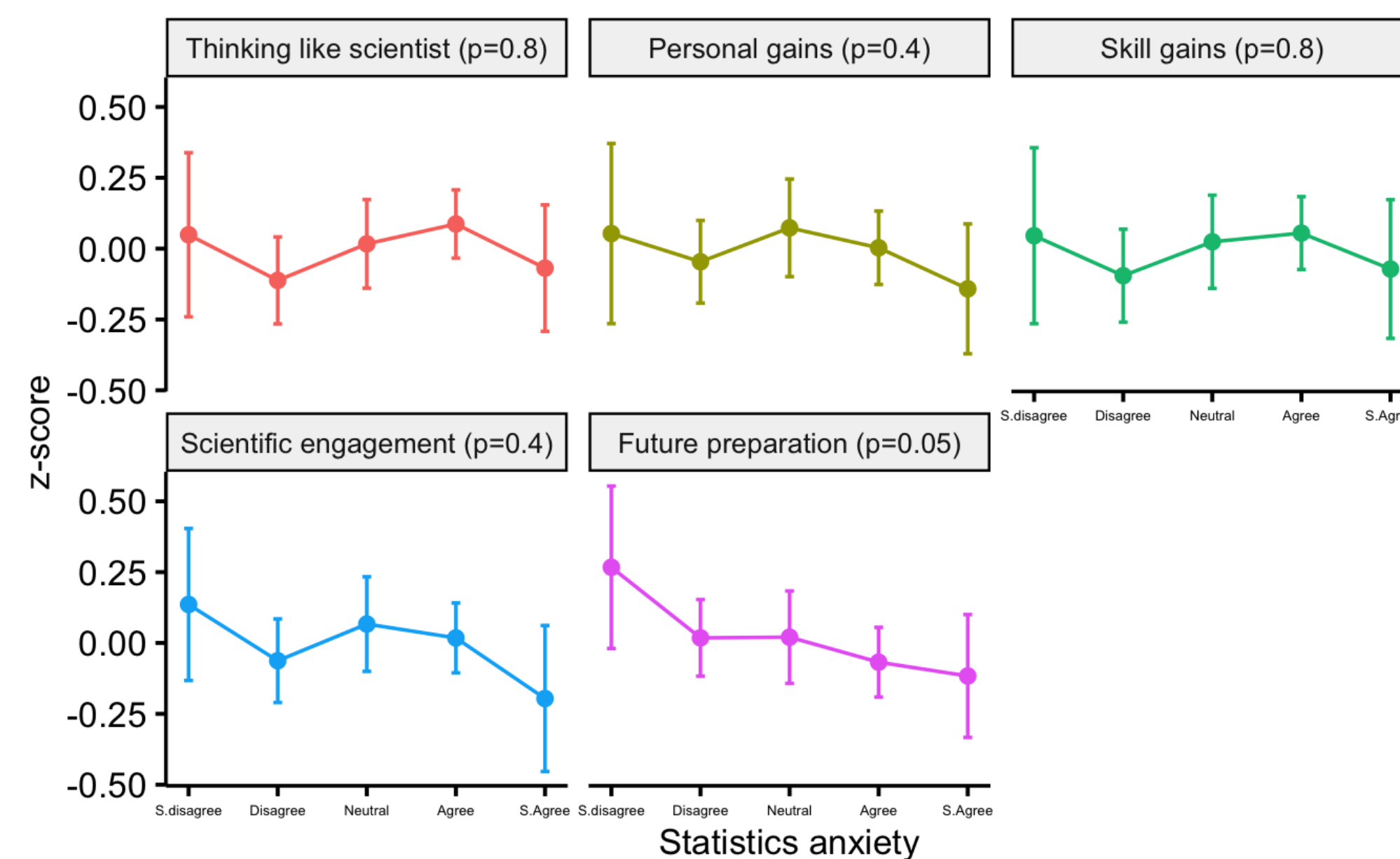
Statistics intentions were more common among male students and students taking courses using R, SAS, or Stata; less common among students from low SES backgrounds and without prior statistics courses.

## Statistics anxiety not associated with lower course gains

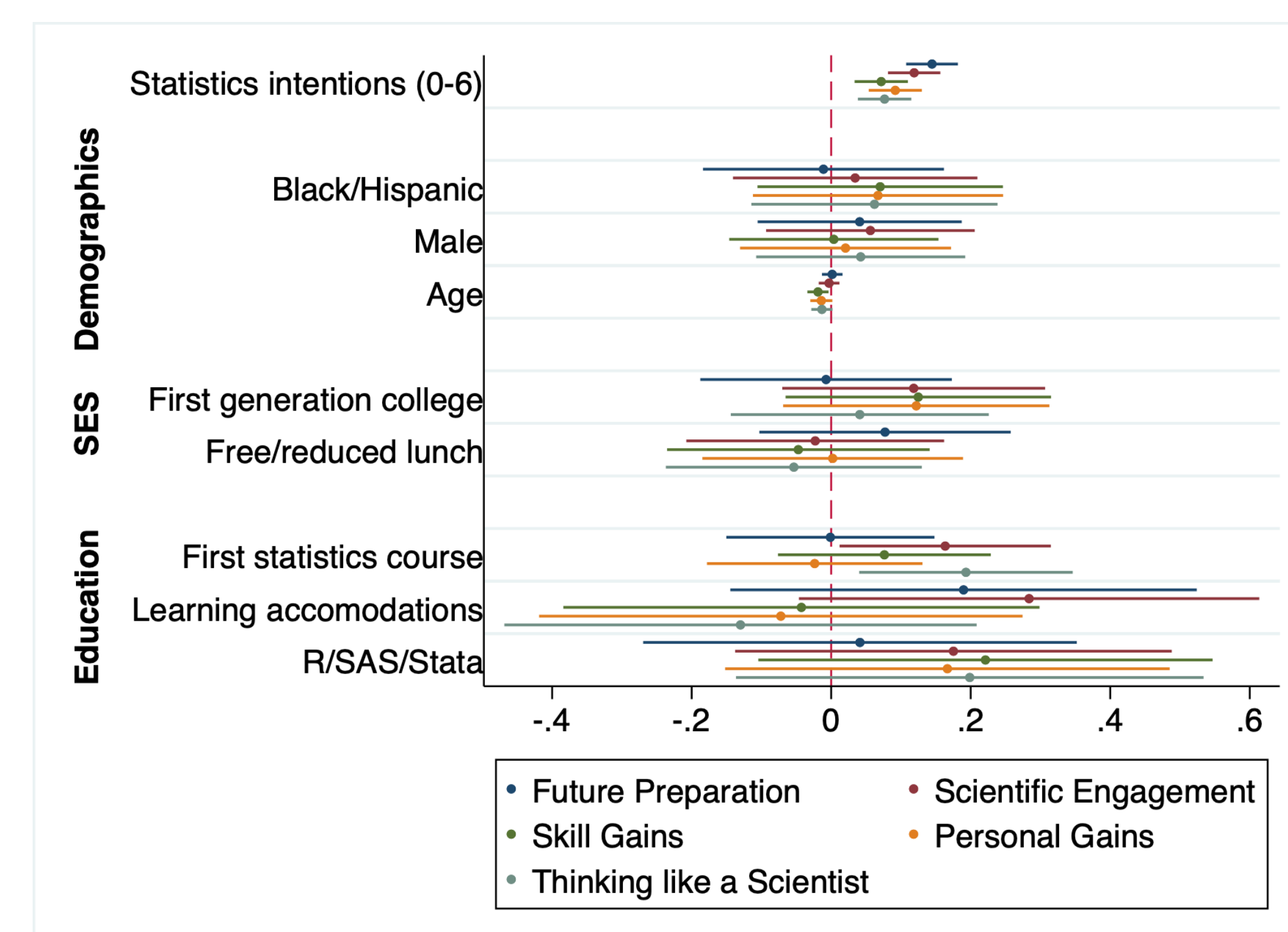
Mixed effects OLS regression with varying intercepts by course.



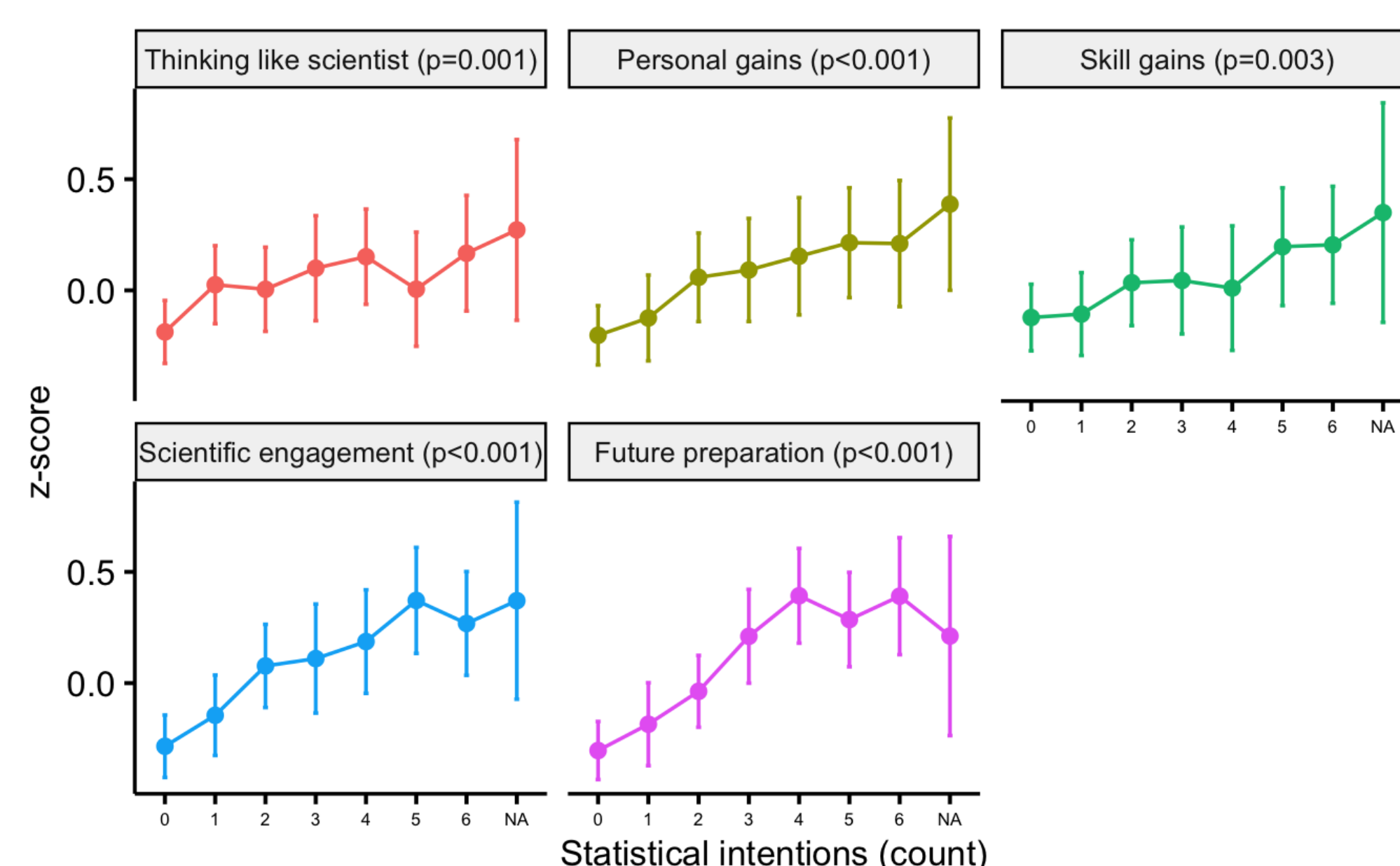
## Anxiety not associated w course gains



## Statistics intentions associated with greater course gains



## Intentions associated w course gains



## Conclusions

Statistical anxiety was more common among first generation and low SES students.

Statistical anxiety was not associated with lower perceived gains from the course, concurring with prior research of course effectiveness with populations less likely to enroll in statistics.

Statistical intentions were associated with greater perceived gains, suggesting students can advance career goals with this project-based course.

Students with greater intentions and lower anxiety were more likely to take courses using code-based statistical packages (R, Stata, SAS), suggesting a matching process between students and software.