

Comparing Student Social Networks and Academic Experiences in Computing and Biology Courses

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Abstract—Previous work has investigated the culture of Computing courses. This paper compares Computing to another STEM discipline with large courses: Biology. Surveying thousands of students in eleven introductory Computing (COMP) and Biology (BIO) courses about their social support networks, we study how these relate to grades, disaggregating by gender. BIO majors reported more connections to other students and more COMP majors reported choosing not to collaborate with peers.

Keywords—Computer Science Education, STEM Education, undergraduate courses, sense of belonging, student experiences and student identities.

I. INTRODUCTION

Science, Technology, Engineering, and Math (STEM) programs are in high demand by students entering college. Collectively, these disciplines have historically struggled to attract and retain a diverse and representative group of scholars [1]. At the same time, there are significant differences between STEM sub-fields: the proportion of undergraduate women studying Biology and Life Sciences (BIO) has been documented to be much higher than that of undergraduate women studying Computer Science and related majors (COMP) [2]. In this study, we explore the social and academic experiences of students in COMP and BIO majors at a large, public, research-intensive, emerging Hispanic-serving STEM institution in the United States. Both BIO and COMP undergraduate programs at this university are considered highly ranked in their given fields with competitive admissions. This project compares the experiences of students with different identities in introductory and required classes in these programs, with a specific focus on how social and academic factors may inform one another.

II. THEORETICAL FRAMEWORK

Biology and computing programs both reflect high social prestige, and both typically have large enrollment classes which are sequenced so material builds off of each other [3].

The gender disparity in enrollment and persistence in Computer Science, especially at the higher education level, is well-documented [4]–[7]. The field of Biology does not have these same underrepresentation patterns: nationally, over 60% of all undergraduate biology majors are women, and other STEM disciplines such as physics and chemistry use biology as a benchmark comparison population [3].

Student class experiences in CS are well-studied, particularly by gender [4], [5], [8]–[10]. Networks consisting of peers, teachers, mentors may impact experience and performance and possibly provide a sense of acceptance or belonging [11]–[14]. Sense of belonging may be particularly relevant for students with aspects of their identities that are minoritized, for example students who are first in their families to attend college, transfer students, and students whose gender is underrepresented in their classes [14]–[16]. This project aims to validate and replicate recent work about student experiences and their connection to sense of belonging: Salguero et al. categorized lack of sense of belonging as one of four factors related to student struggles in computing classes [17]; Krause-Levy et al. used the same survey instrument and connected the existence of student social support networks in their classes to higher course grades [18].

III. RESEARCH QUESTIONS

We explore the following research questions:

- 1) Are there differences in the academic experiences and social support networks among computing majors in computing courses and biology majors in biology courses?
- 2) In what ways do students' experiences of social support in key undergraduate classes change throughout the term?

These questions are addressed through the lens of student identities, disaggregating by gender. We use students' responses to questions about their networks and their grades to understand these differences.

IV. POSITIONALITY STATEMENTS

The research took place at a large research university located in the western region of the U.S. The researchers recognize the possible impacts their own positions and experiences may have on this work: the 3rd, 4th and 5th authors are faculty members at this institution and serve on its CSE undergraduate curriculum committee and the 4th and 5th author regularly teach some of the classes included in the survey collection.

V. RESEARCH DESIGN

The research questions are addressed by quantitative analysis of survey responses and course performance metrics. Multiple COMP and BIO classes were selected to represent core undergraduate classes taken by all students in the respective programs. A survey was administered multiple times in each class over a single term. Through this survey, students self-reported the extent of their social support network in the course. De-identified survey response data were associated with grade data and demographic information provided by the registrar of the university (following IRB-reviewed protocols).

VI. DATA COLLECTION

A. Survey administration

In Fall of 2021, instructors of 8 participating COMP classes and 3 participating BIO classes distributed the same surveys to their students in one of the following ways: a standalone survey sent to students three times during the course; add-on questions to the instructor’s own pre-class survey, mid-term feedback form, and end-of term survey; or add-on questions to regular (weekly) class assignments. Survey responses dated any time before the end of week 2 of the (10-week) term were labelled as *pre* course responses; responses dated between the end of week 2 and end of week 8 were labelled as *mid* course responses; responses dated any time after the end of week 8 were labelled as *post* course responses. This paper focuses on student responses to one survey question: *How many people are you comfortable reaching out to for support or collaboration with this class?* Possible responses were 0, 1, 2, 3, 4, 5+, or “N/A (I choose not to collaborate or get support)”. We refer to this question as Nsupport and we refer to the N/A response as “Avoid support”.

We only analyze survey responses from undergraduate students enrolled in the COMP and BIO classes whose majors are related to COMP and BIO (respectively). Majors included in COMP are Computer Science, Cognitive Science, Mathematics, Bioengineering, Electrical and Computer Engineering. Majors included in BIO are Bioengineering, Biology, Chemistry, and Nanoengineering (we selected majors for which the course participating in the study are required of all students).

B. Grade and Gender Data

The data point for each unique student-course pair was the set of survey responses by that student for that course, along with demographic and course grade data. A standard conversion from course grades to points was used: A=4, B=3,

C=2, D=1, F=0; the + or - modifiers on a letter grade add or subtract 0.3 (respectively).

Gender data was drawn from university records, where the categories Female, Male, Non-binary/X, and Unknown are used. The categories are referring to student gender, and not sex assigned at birth, and are defined by the university such that Female includes trans female, Male includes trans male, X includes individuals who identify as non-binary or other gender identities. This university recently instituted a “Gender Recognition and Lived Name” policy to give students an opportunity to change their name and gender marker in the university system [19]. We will be using the markers “woman (W)”, “man (M)”, and “nonbinary student (X)” as the gender categories for this paper to emphasize that these labels are not referring to sex assigned at birth and only gender. These correspond to the university-level markers: Female to woman, Male to man, Non-binary/X to nonbinary (X) and Unknown being unchanged. Due to this study taking place during the active implementation of the new university policy, it is not possible to know which data reported from various departments and student record categories was utilizing the new policy at the time of this study. Therefore, for the diagrams in this work the categories of “unknown” and “nonbinary” are collapsed into a single representation as we are not able to determine if the categories were reported separately or combined in the various data sets. This does not mean these categories are equivalent, but that we do not have access to enough information to make substantial claims about them separately.

There are 4717 responses from 2257 COMP-majors in COMP classes and 2037 responses from 466 BIO-majors in BIO classes.

VII. RESULTS

A. Social support networks in COMP and BIO classes

Frequencies of Nsupport responses are summarized in Table I for survey responses from COMP-majors in COMP classes and BIO-majors in BIO classes, respectively, who reported zero, positive, “N/A (I choose not to reach out and/or collaborate)” , or left the question blank at each point in the term. There is a higher rate of missing survey responses for post surveys among COMP-majors. BIO-majors tended to report nonzero social support networks while COMP-majors were more likely to report zero support networks (including reporting choosing not to collaborate).

B. Changes in social support networks over the term

The *pre* and *post* survey responses tell us if students reported connections increased or decreased. Among COMP-majors in COMP classes who responded to a pre and a post survey (n=868) surveys, 34% (298) reported their support network remained the same, 33% (291) reported support decreased from beginning of the term to end of the term, and 32% (279) reported support increased from the beginning of the term to the end. Among BIO-majors in BIO classes, who responded to a pre and a post survey (n=267) 39% (103) reported support networks staying the same throughout the term, 26% (70)

Nsupport	COMP pre	COMP mid	COMP post
0	371 (16%)	235 (10%)	138 (6%)
1 - 4	1085 (48%)	1216 (53%)	633 (28%)
5+	330 (15%)	227 (10%)	147 (7%)
Avoid support	51 (2%)	102 (5%)	72 (3%)
No response	420 (19%)	477 (22%)	1267 (56%)

Nsupport	BIO pre	BIO mid	BIO post
0	25 (5%)	10 (2%)	17 (4%)
1 - 4	234 (50%)	254 (55%)	246 (53%)
5+	91 (20%)	74 (16%)	77 (17%)
Avoid support	5 (1%)	5 (1%)	8 (2%)
No response	111 (24%)	123 (26%)	118 (24%)

TABLE I: Frequency tables for pre, mid, post survey responses across the COMP and BIO courses, where percentages are computed relative to all COMP-majors and BIO-majors who ever responded to a survey (resp.). “No response” indicates a student answered another survey, but not at the indicated time.

reported support decreased from beginning of the term to end of the term, and 35% (94) reported support increased from the beginning of the term to the end.

C. Academic Performance in COMP and BIO Classes

Aggregating respondents’ grades in COMP and BIO classes separately: the median grade point for COMP-majors in COMP classes is 3.3, the mean is 2.85; the median grade point for BIO-majors in BIO classes is 4.0, the mean is 3.61.

D. Social Support Networks and Academic Performance

Based on prior work, we predicted we would see a relationship between student social support networks at the start of the term and course grades. Figure 1 presents the distribution of grade points, grouped by reported Nsupport in pre-survey responses. Both for COMP-majors and for BIO-majors, respondents who reported having 0 social network connections have lower median grades. Among COMP-majors in COMP classes, the median grade of respondents who reported they Avoid Support and respondents who reported large (5+) social network connections are higher.

E. Gender Disaggregated Analysis for COMP and BIO

The gender distributions of BIO and COMP classes in the study were very different, see Table II. In particular, approximately 67% of BIO-major respondents in BIO-classes were women, compared with approximately 26% of COMP-major respondents in the COMP-classes who were women. In Table III, there appear to be more gendered differences in the median grades among COMP-majors in COMP classes than among BIO-majors in BIO classes (among survey respondents).

Gender	COMP	BIO
Women	540 (26%)	312 (67%)
Men	1450 (71%)	149 (32%)
Non-binary/Unknown	49 (2.4%)	<10 (< 1%)
Total	2039	465

TABLE II: Genders of COMP-major respondents in COMP classes and of BIO-major respondents in BIO classes.

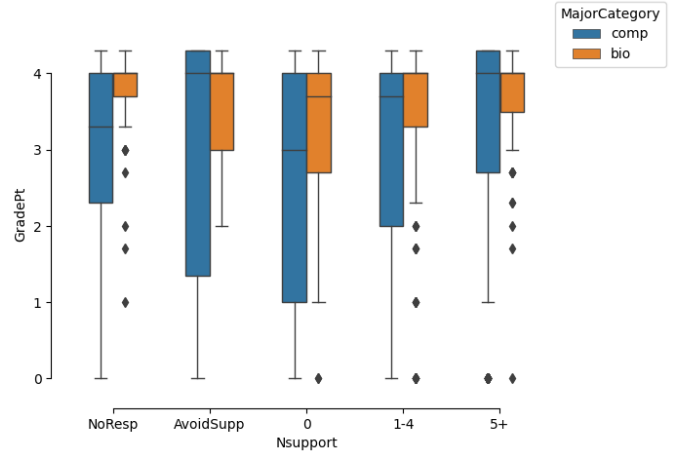


Fig. 1: Distribution of grade points by Nsupport responses in pre-surveys, comparing COMP and BIO respondents. NoResp means majors in the classes who did not respond to any surveys. NoSup means respondents who reported Avoid Support.

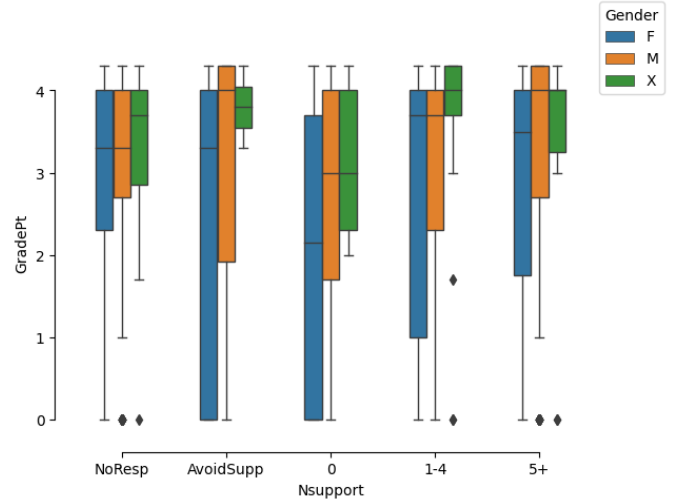


Fig. 2: Distribution of grade points by Nsupport responses in pre-surveys of COMP-majors in COMP classes, comparing across genders. NoResp means majors in the classes who did not respond to any surveys.

F. Social Support Networks and Academic Performance by Gender and Major

We repeat the analysis of academic performance and social networks, disaggregating by both gender and major. Table III reports the median grade points of COMP-majors in COMP classes and BIO-majors in BIO classes disaggregated by gender, and grouped according to reported Nsupport in pre-surveys. The distributions of grade points for these groups is displayed in Figures 2 and Figures 3.

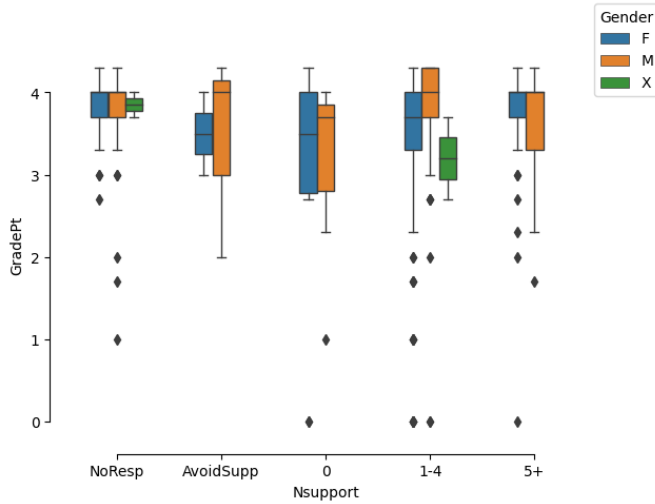


Fig. 3: Distribution of grade points by Nsupport responses in pre-surveys of BIO-majors in BIO classes, comparing across genders. NoResp means majors in the classes who did not respond to any surveys.

Gender	W		M		X/U	
	COMP	BIO	COMP	BIO	COMP	BIO
Nsupport pre						
0	2.15	3.50	3.00	3.70	3.00	*
1-4	3.70	3.70	3.70	4.00	4.00	
5+	3.50	4.00	4.00	4.00	4.00	
Avoid support	3.30	3.50	4.00	4.00	3.80	
No response	3.30	4.00	3.30	4.00	3.70	
Overall Median	3.30	4.00	3.70	4.00	4.00	

TABLE III: Median grade point for respondents, disaggregated by major, gender, and reported Nsupport in pre-survey. X/U (Non-binary/unknown) not reported for BIO due to small (<10) sample size.

In both the gender disaggregated data and the aggregate data, we see lower median grade points for respondents who reported 0 Nsupport at the start of the term. However, in the aggregate data we saw respondents choosing not to collaborate (Avoid Support) had higher median grade points, whereas we don’t see this pattern among women when disaggregating by gender: in Table III, women who reported “Avoid support” had slightly lower median grade points than those who reported positive Nsupport at the start of term.

VIII. DISCUSSION

STEM majors generally differ in their course requirements but, at our university, computing and biology courses share some important features: they are highly sought-after, with large enrollments, and are considered important stepping stones to lucrative future career opportunities. In this short paper, we compared the social networks and academic experiences for students in computing and biology courses.

Social networks appear to relate to academic performance in the class, with both COMP and BIO respondents who reported positive social networks at the start of the term having higher

median grades in these courses than those with zero people they could reach out to. This finding replicates prior work on the role of social networks in academic performance [18]. Some possible explanations for this include the value of study groups, where students can test one another on course contents and quickly get formative feedback and peer explanations. Beyond study groups, positive Nsupport may be related to a student being better connected to the resource structures available on campus, and therefore more familiar with some of the “hidden curriculum” of higher education such as how to access help in office hours, tutoring, and how to efficiently navigate course requirements.

We saw that COMP-majors more frequently reported having zero people they were comfortable reaching out to for support or collaboration in their COMP-classes, compared to BIO-majors with respect to their BIO-classes. Also, COMP-majors more frequently reported choosing not to collaborate or get support in their COMP-classes, compared to BIO-majors in their BIO-classes. We are concerned that a culture of competitiveness may be connected with students actively choosing not to work with peers in their classes. Another reason we’ve heard anecdotally from some COMP-students is that vigilant monitoring and enforcement of academic integrity policies in terms of code similarity and (anti-)collaboration policies may also have a chilling effect on the classroom community.

This is a work in progress: we plan to continue our comparison of the experiences of students in computing and biology classes, analysing the data disaggregated by students’ racial and ethnic identities, and intersectionally. However, we recognize limitations in the dataset we have collected: the surveys do not have complete participation (as seen in the last row in Table I), and aggregating class grades and survey data across 11 different classes may lead to confounds with class policies and grade distributions). Institutional demographic data was paired with survey data, which gives a more complete data set but means that gender classifications are restricted to those used by the university. While the newer university policy [19] aimed to bring university-assigned labels closer to students’ self-identify, this does not imply that all students did so if desired, nor that they were even aware of the policy. More nuanced approaches to gender and belonging, such as adding self-identifying gender items to the survey [20], would add to this existing work.

Future work will continue to examine the interplay between social networks and academic experiences in STEM disciplines, particularly focusing on how these interact with multiple aspects of students’ identities along student’s progress through their undergraduate programs.

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