The Benefits of Socially Responsible Computing in Early Computing Courses

A Multi-Institutional Study at Primarily Undergraduate Hispanic-Serving Institutions

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Motivation

The CSU system serves close to **half a million** undergraduate students.

48% of them identify as Hispanic/Latino.

Source: Institutional data

Motivation

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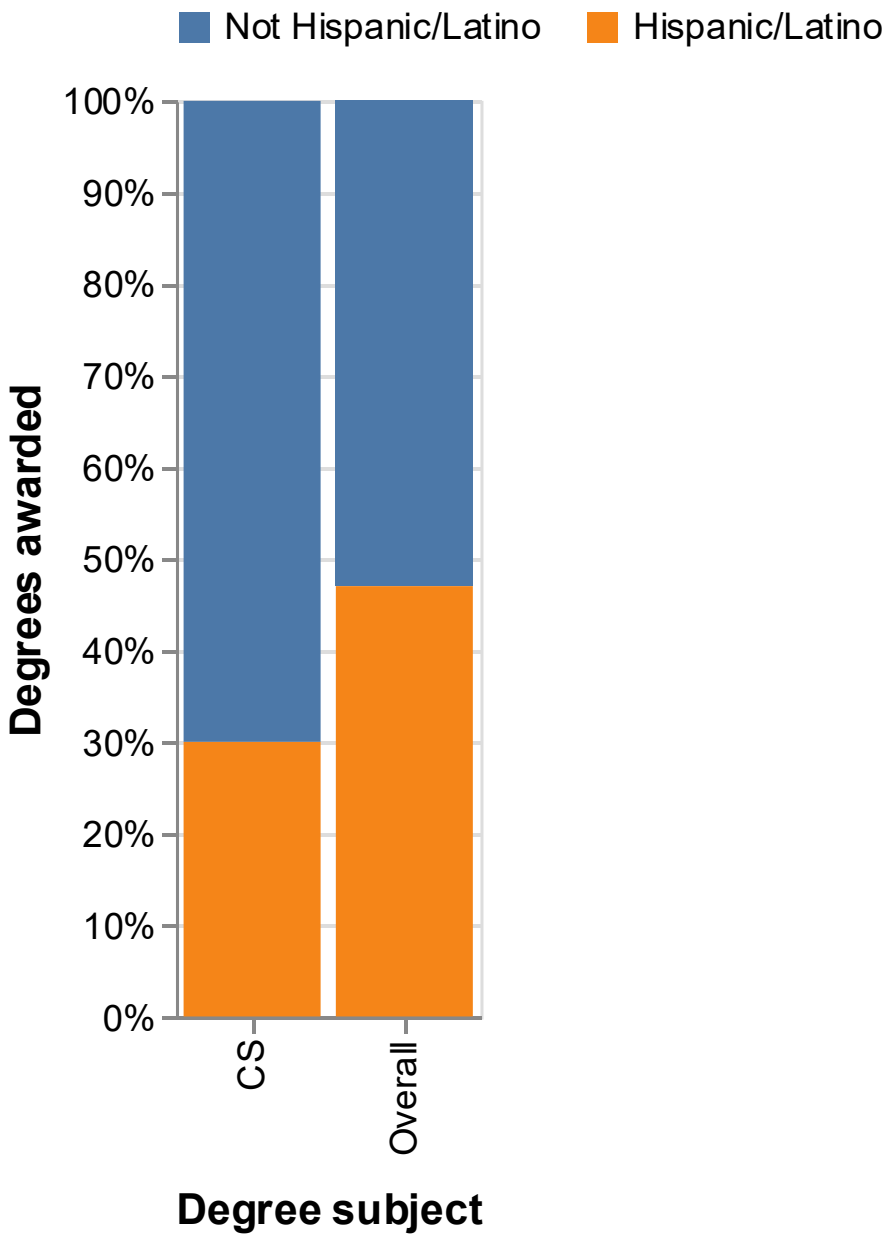
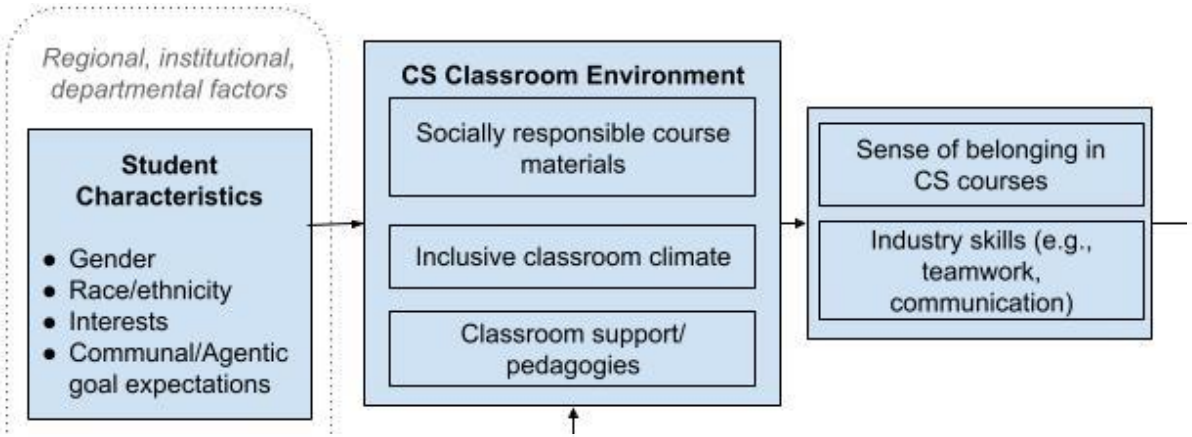
48% of them identify as Hispanic/Latino.

30% of CS degrees were awarded to students identifying as Hispanic/Latino in 2024–2025.



Source: Institutional data

Our goals



Session 1: What the Students Think ICER '19, August 12–14, 2019, Toronto, ON, Canada

Alignment of Goals and Perceptions of Computing Predicts Students' Sense of Belonging in Computing

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ABSTRACT

The lack of diversity has been a troubling issue for the field of computing. As the industry continues to expand, it is imperative that diversity levels in computing fields increase to fill the ever-growing number of computing jobs and to represent the technological needs of a diverse populace. Our research seeks to better understand the factors that lead to this lack of diversity by analyzing data from computing majors from colleges within the United States and Canada. Our study reveals that students of different demographic backgrounds have varying levels of communal values, which, depending on how they perceive the affordance of computing to fulfill such values, predict their sense of belonging in computing, which is an important predictor of student retention.

KEYWORDS

belonging, diversity, inclusion, social impact, communal goals

ACM Reference Format:

Colleen Lewis, Paul Bruno, Jonathan Raygoza, and Julia Wang. 2019. Alignment of Goals and Perceptions of Computing Predicts Students' Sense of Belonging in Computing. In *International Computing Education Research Conference (ICER '19), August 12–14, 2019, Toronto, ON, Canada.* ACM, New York, NY, USA, 9 pages. https://doi.org/10.1145/3291279.3339426

1 INTRODUCTION

Computing fields suffer from a lack of diversity [10, 19, 20, 22, 26, 28, 37]. This lack of diversity is problematic for a number of reasons. First, the computing industry is one of the fastest growing industries. For example, at current graduation rates, by the year 2020 the U.S. will only be able to fill 30% of domestic computing jobs with U.S. graduates [8]. Making computing more accessible to individuals from a wider range of backgrounds will increase the total number of computing graduates who may enter the computing workforce. Furthermore, as technology continues to expand, diversity of thought is vital for innovation [24]. Creating useful products for society requires a diverse group of developers who understand the various issues plaguing society [6, 31].

Diekman and colleagues have argued that women are less interested in science, technology, engineering, and math (STEM) because they do not believe computing will allow them to meet their personal goals [7, 13, 15, 16]. They have developed an empirical basis for *goal congruity theory*, which posits that students' personal goals and their perceived ability to fulfill those goals within the field (i.e., goal affordances) need to be aligned in order for student so be interested in a particular field [7, 13, 15, 16]. Put simply, when one does not believe they will be able to meet their personal goals in a given career path, they are unlikely to pursue that career path.

Specifically, Diekman focuses on alignment between the affordances of STEM and students' communal goals, or a desire to work with and to the benefit of others. Of relevance to the current work, underrepresented groups in computing (e.g., women; students of color; first generation college students)[1] tend to hold strong communal goals [1, 13, 15, 33, 34]. However, technical fields like computing are believed to afford low opportunity to be communal compared to other fields, such as the social sciences or life sciences (see [13, 34]).

For computing majors, the dissonance between their goals and their perception of the goal affordances of computing may lead to a lower sense of belonging, which has been linked to higher likelihoods of leaving computing-related fields [3, 36]. This is particularly important to the field of computing since it has been noted that certain underrepresented groups are more likely than others to leave a computing major [11, 18].

We analyze survey responses from 5,821 students pursuing a computing-related undergraduate degree in the U.S. from over 100 institutions. As with prior work, we find that students from underrepresented groups are both more likely to have communal (rather than individualistic) goal orientations and to have a weaker sense of belonging with computing. Consistent with theoretical predictions, we find that among students majoring in computing, communal goal orientations negatively predict sense of belonging in computing and that this relationship is moderated by the extent to which

[1] Of course, these groups are not independent; students may have several underrepresented identities at once (e.g., women of color).

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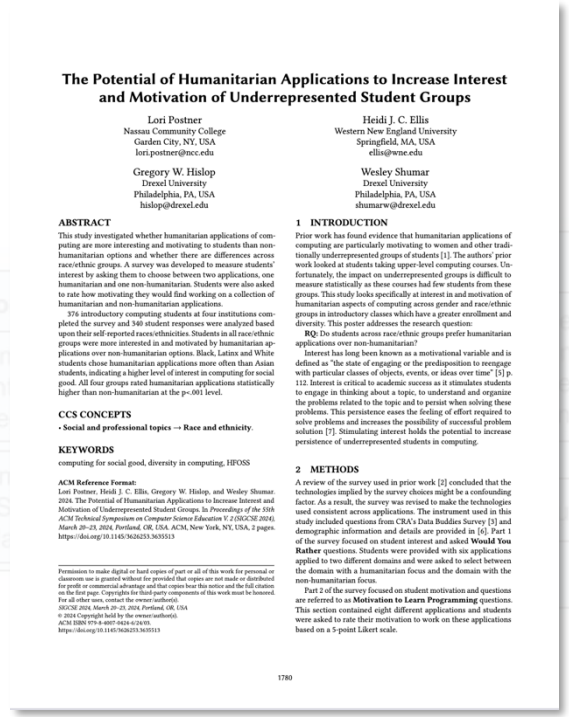

The Potential of Humanitarian Applications to Increase Interest and Motivation of Underrepresented Student Groups

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ABSTRACT

This study investigated whether humanitarian applications of computing are more interesting and motivating to students than non-humanitarian options and whether there are differences across race/ethnic groups. A survey was developed to measure students' interest by asking them to choose between two applications, one humanitarian and one non-humanitarian. Students were also asked to rate how motivating they would find working on a collection of humanitarian and non-humanitarian applications.

376 introductory computing students at four institutions completed the survey and 340 student responses were analyzed based upon their self-reported races/ethnicities. Students in all race/ethnic groups were more interested in and motivated by humanitarian applications over non-humanitarian options. Black, Latinx and White students chose humanitarian applications more often than Asian students, indicating a higher level of interest in computing for social good. All four groups rated humanitarian applications statistically higher than non-humanitarian at the $p<.001$ level.

CCS CONCEPTS

• **Social and professional topics** → **Race and ethnicity**.

KEYWORDS

computing for social good, diversity in computing, HFOSS

ACM Reference Format:

Lori Postner, Heidi J. C. Ellis, Gregory W. Hislop, and Wesley Shumar. 2024. The Potential of Humanitarian Applications to Increase Interest and Motivation of Underrepresented Student Groups. In *Proceedings of the 55th ACM Technical Symposium on Computer Science Education V. 2 (SIGCSE 2024), March 20–23, 2024, Portland, OR, USA.* ACM, New York, NY, USA, 2 pages. https://doi.org/10.1145/3626253.3635513

1 INTRODUCTION

Prior work has found evidence that humanitarian applications of computing are particularly motivating to women and other traditionally underrepresented groups of students [1]. The authors' prior work looked at students taking upper-level computing courses. Unfortunately, the impact on underrepresented groups is difficult to measure statistically as these courses had few students from these groups. This study looks specifically at interest in and motivation of humanitarian aspects of computing across gender and race/ethnic groups in introductory classes which have a greater enrollment and diversity. This poster addresses the research question:

RQ: Do students across race/ethnic groups prefer humanitarian applications over non-humanitarian?

Interest has long been known as a motivational variable and is defined as "the state of engaging or the predisposition to reengage with particular classes of objects, events, or ideas over time" [5] p. 112. Interest is critical to academic success as it stimulates students to engage in thinking about a topic, to understand and organize the problems related to the topic and to persist when solving these problems. This persistence eases the feeling of effort required to solve problems and increases the possibility of successful problem solution [7]. Stimulating interest holds the potential to increase persistence of underrepresented students in computing.

2 METHODS

A review of the survey used in prior work [2] concluded that the technologies implied by the survey choices might be a confounding factor. As a result, the survey was revised to make the technologies used consistent across applications. The instrument used in this study included questions from CRA's Data Buddies Survey [3] and demographic information and details are provided in [6]. Part 1 of the survey focused on student interest and asked **Would You Rather** questions. Students were provided with six applications applied to two different domains and were asked to select between the domain with a humanitarian focus and the domain with the non-humanitarian focus.

Part 2 of the survey focused on student motivation and questions are referred to as **Motivation to Learn Programming** questions. This section contained eight different applications and students were asked to rate their motivation to work on these applications based on a 5-point Likert scale.

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https://doi.org/10.1145/3626253.3635513

1780

[Lewis et al.]

[Postner et al.]

To provide opportunities for students to succeed in Socially Responsible Computing assignments that draw on **diverse backgrounds and interests,** and to measure associated changes in students' **sense of belonging** in early CS courses.

Broader project context

Alliance of six CSU campuses

Broader project context

Alliance of six CSU campuses

Broader project context

Alliance of six CSU campuses

High variance in:

- Acceptance rates
- CS enrollment policies
- Student demographics
- Student socioeconomic backgrounds
- Class sizes

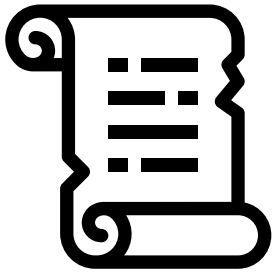
Socially Responsible Computing

Coursework that encourages students to consider the social and ethical implications of their work, and to bring their own cultural assets into the classroom.

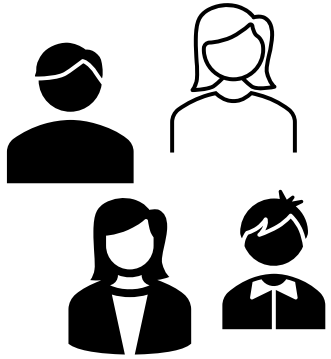
Example 1: Tip Allocation Assignment

- **Target CS Topic:** Conditional control flow.
- **Real-World Context:** American practice of tipping at restaurants; a diner leaves a tip and the employees pool tips and allocate the pool by job title.

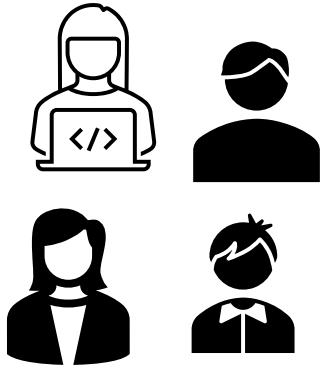
Pre-reading about tipping and “power to/power over”.



Group worksheet analyzing different tip allocation algorithms.



Students designed their own algorithms to be more fair.



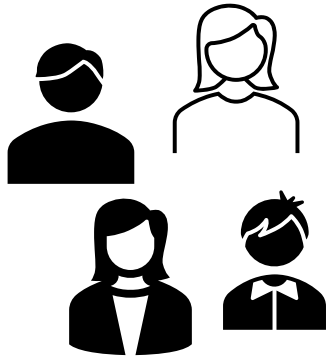
Reflection and discussion

Example 2: Data-centric Intro to Computing

- **Target CS Topic:** Data-centric computing assignments in TypeScript, including a significant data visualization component.
- **Real-World Context(s):** CS education access in California, data from local non-profit organizations, project topics chosen by students.

Pre-readings based on the chosen topic

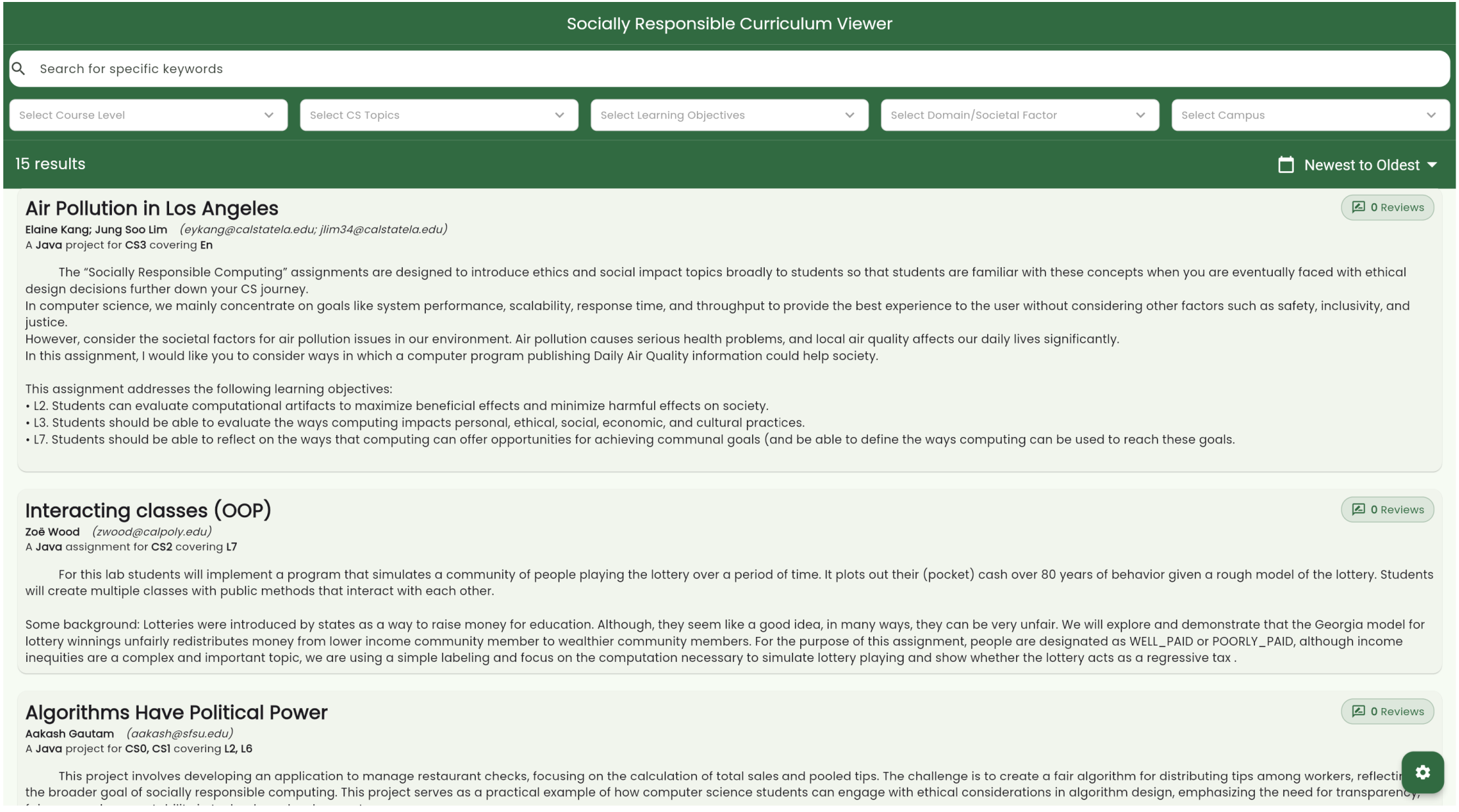
Group work involving data analysis and interpretation



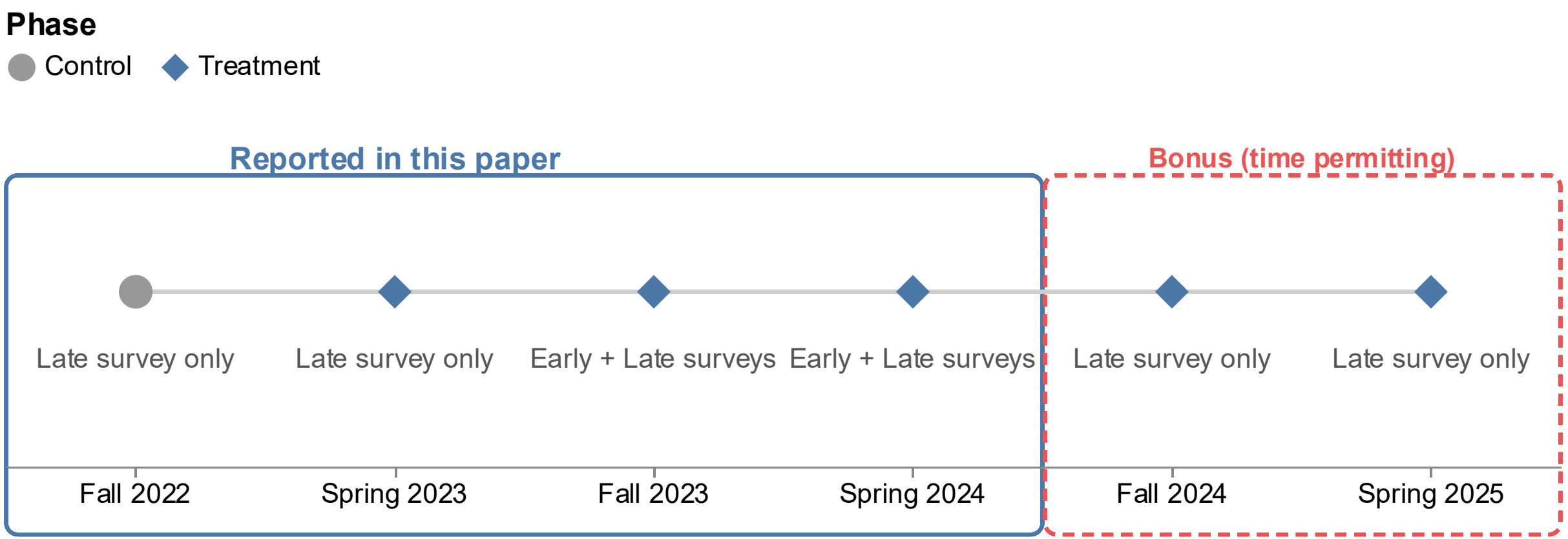
Final report and class presentation

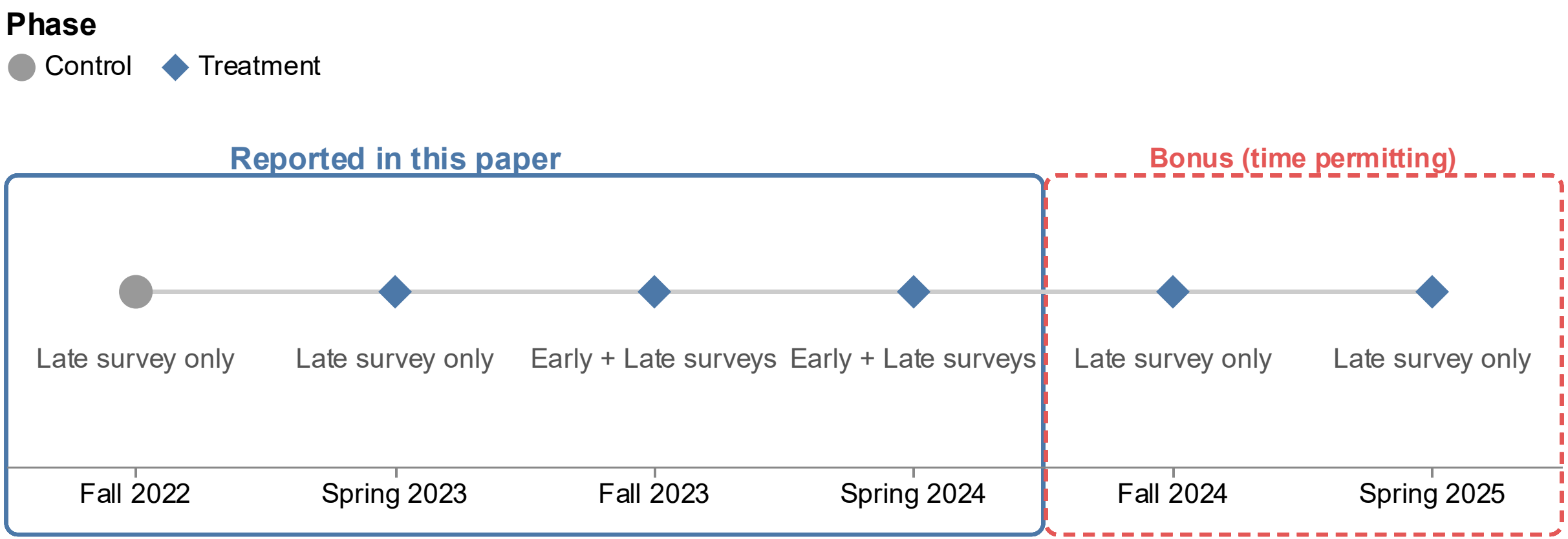
Described in more detail: SIGCSE ‘24

And more (https://curriculum.bpcsrc.org)



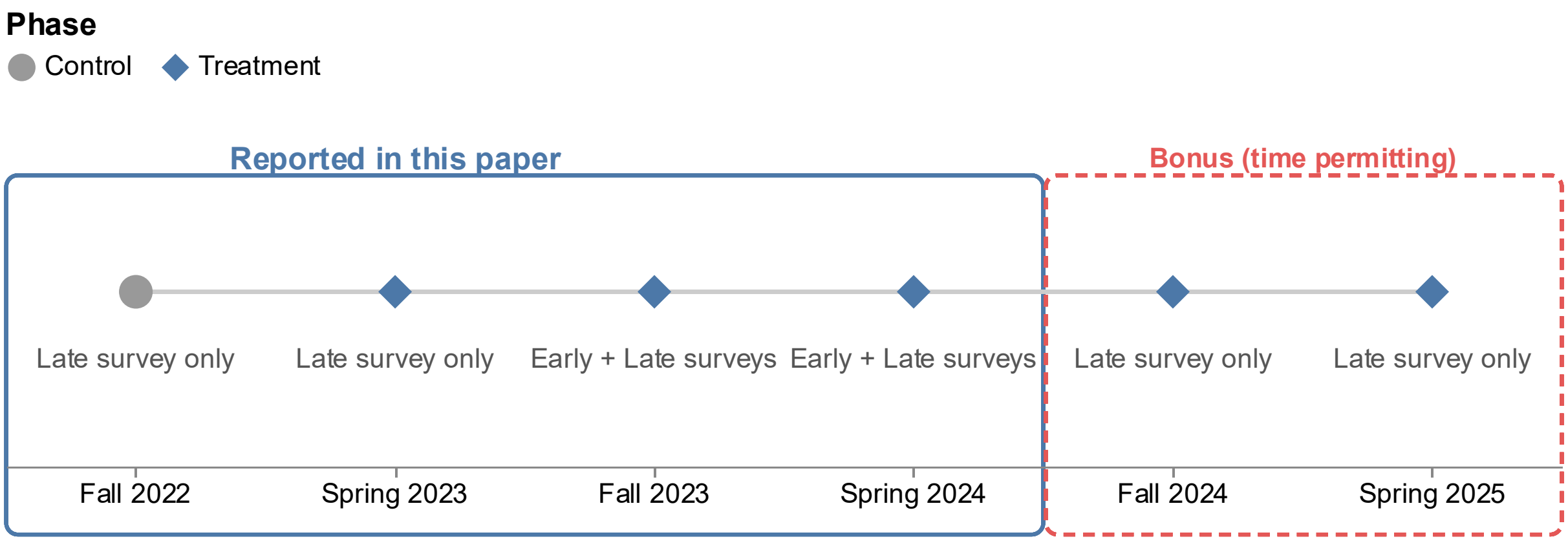
Study overview


Phase
Control
Treatment
Reported in this paper
Bonus (time permitting)
Late survey only
Late survey only
Early + Late surveys
Early + Late surveys
Late survey only
Late survey only
Fall 2022
Spring 2023
Fall 2023
Spring 2024
Fall 2024
Spring 2025



Survey questions about

- Demographic information
- Communal goal endorsement
- Perceived learning and agency from SRC assignments
- Sense of belonging in computing
- Interference in learning from external factors



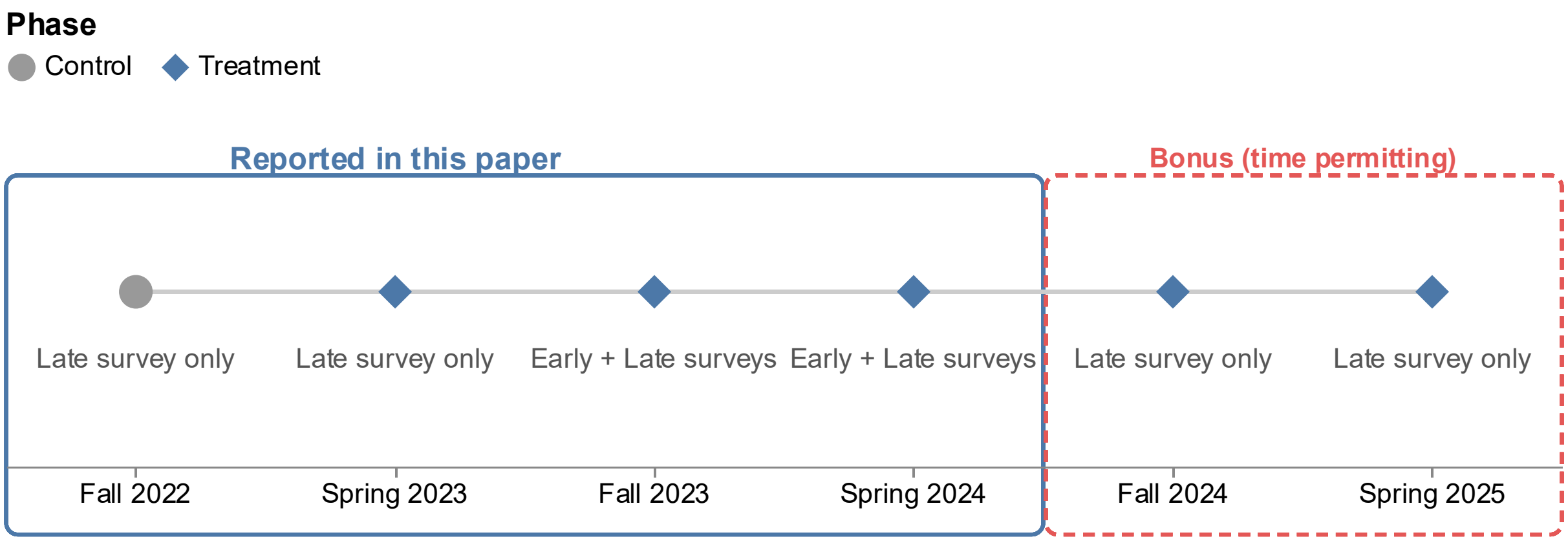
Survey questions about

- Demographic information
- **Communal goal endorsement**
- Perceived learning and agency from SRC assignments
- Sense of belonging in computing
- Interference in learning from external factors

No significant difference between Hispanic/Latino students and other students.

But generally high endorsement overall.

Koli Calling '25



Survey questions about

- Demographic information
- Communal goal endorsement
- Perceived learning and agency from SRC assignments
- **Sense of belonging in computing**
- **Interference in learning from external factors**

Rest of this talk (but happy to answer questions about the rest!)

Sense of belonging

Between-Term Analysis

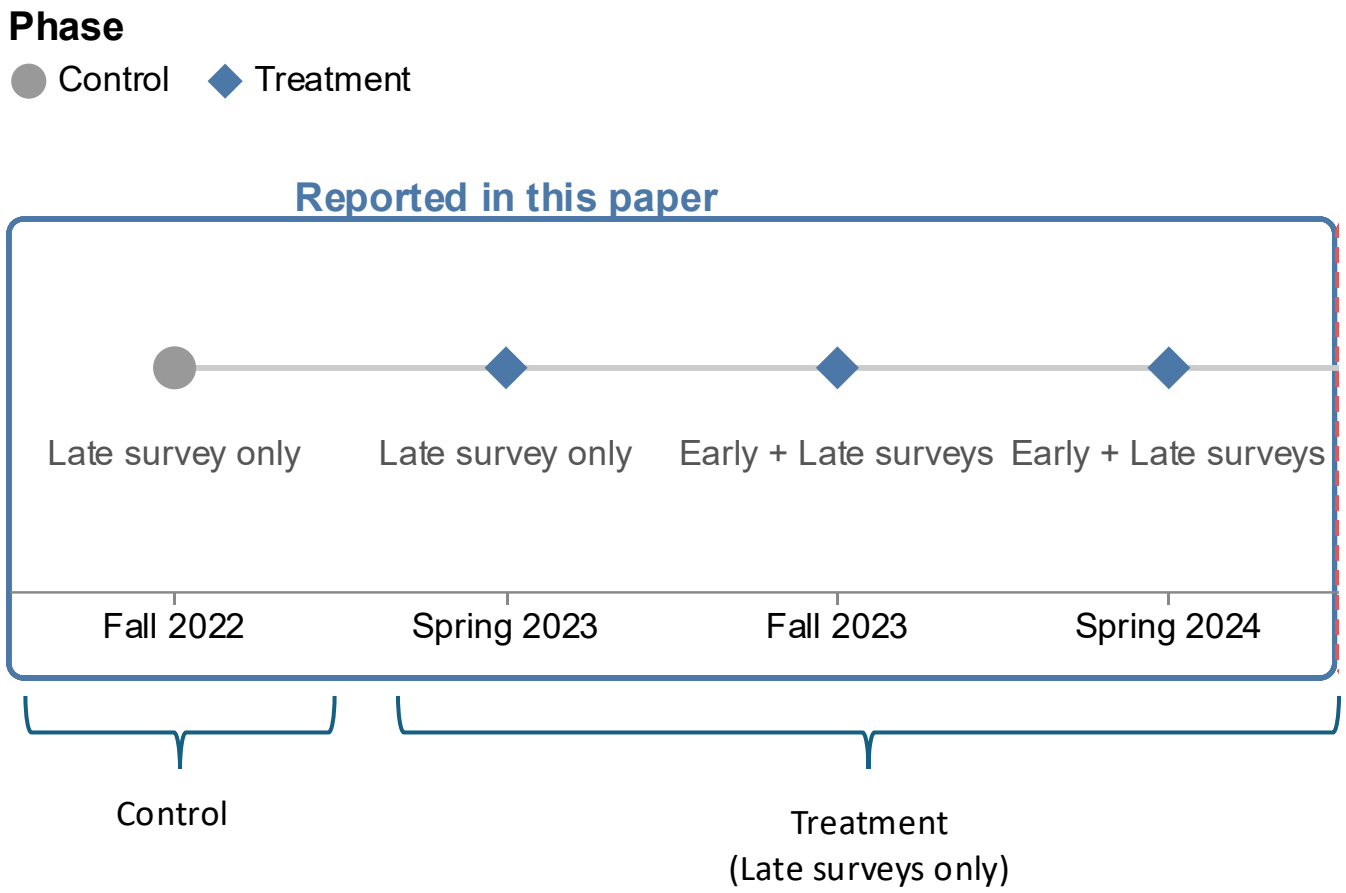
Control group: **Fall 2022**

Treatment groups:

Spring 2023, Fall 2023, Spring 2024

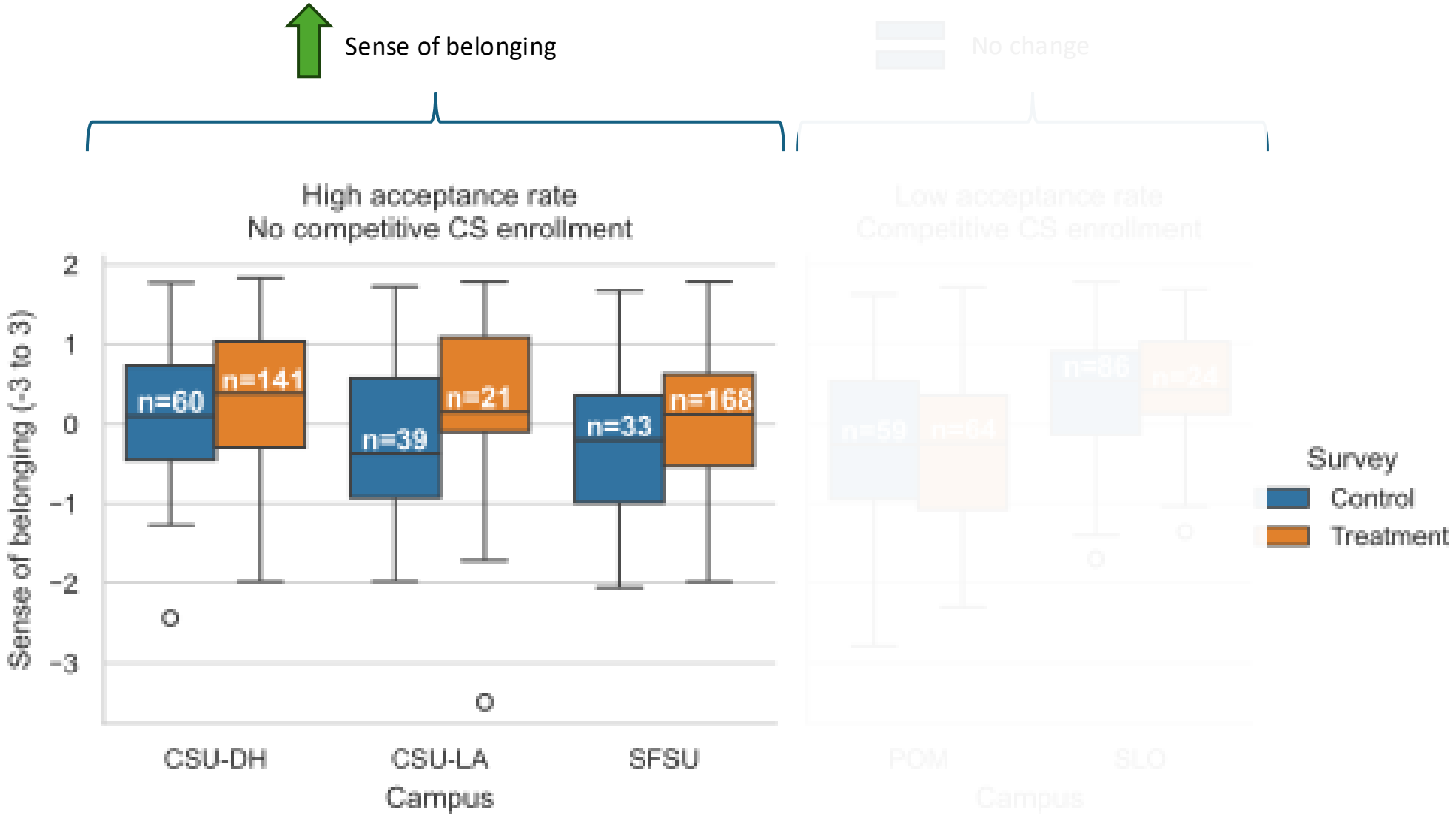
Only **Late** surveys were considered for the sake of comparison.

Only courses that had respondents in both groups.



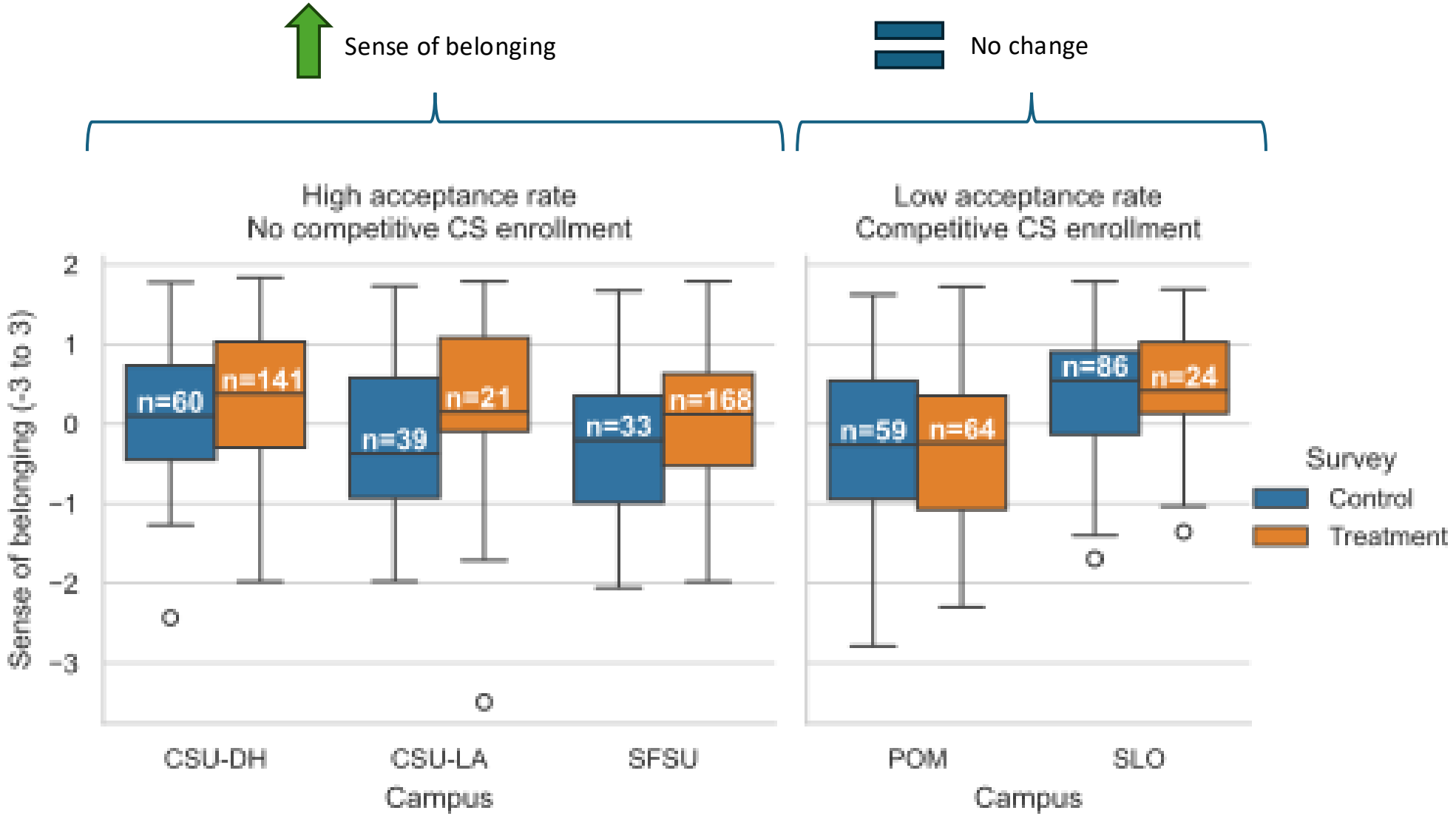
Survey questions source: Moudgalya et al.

Result: Between-Terms (only CS 0/CS 1)



Note: Sense of belonging scores were adjusted based on a CFA. Details in the paper.

Result: Between-Terms (only CS 0/CS 1)



Note: Sense of belonging scores were adjusted based on a CFA. Details in the paper.

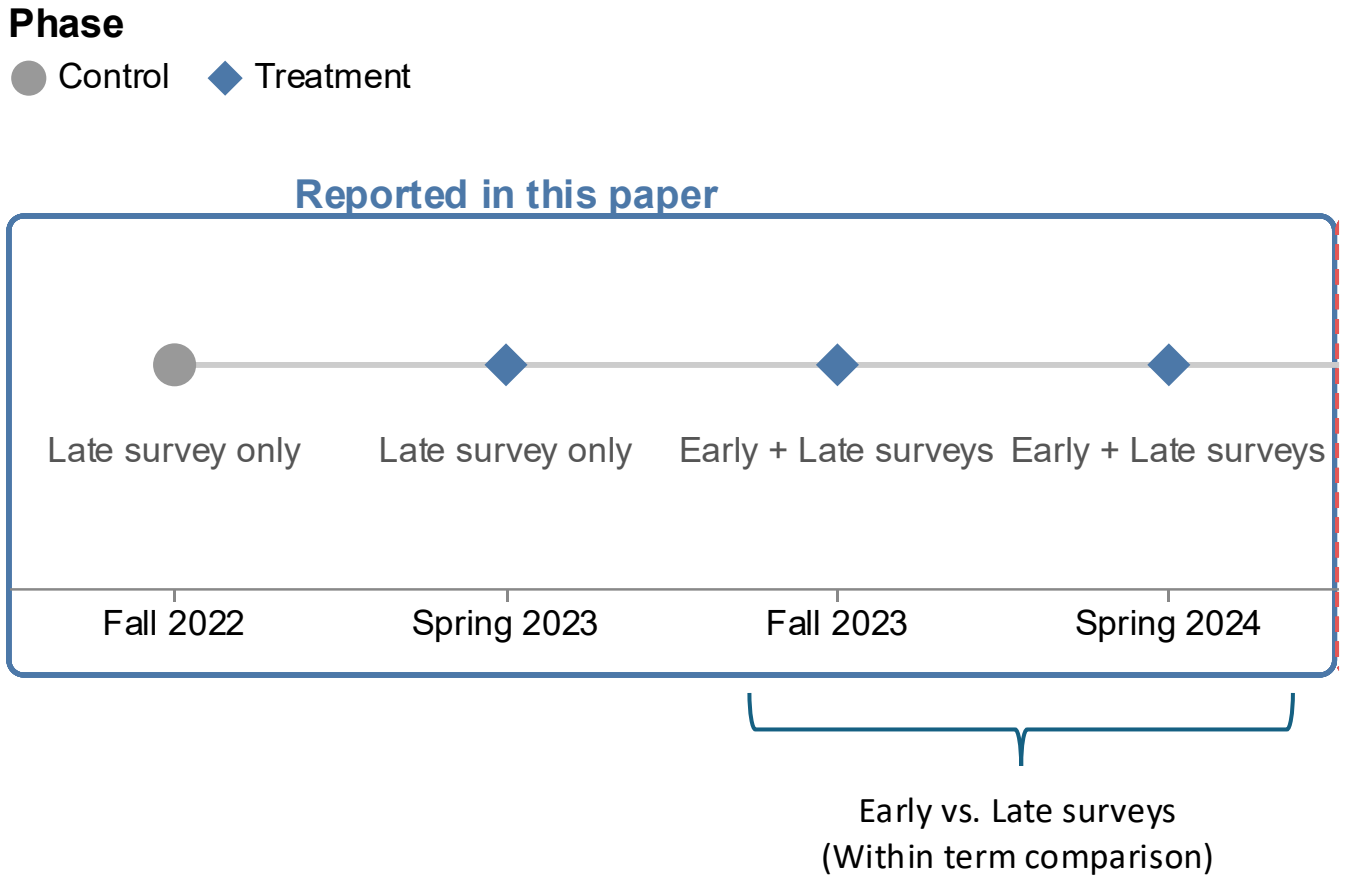
Within-Term Analysis

Studied terms that had an Early and Late survey.

Fall 2023 and Spring 2024

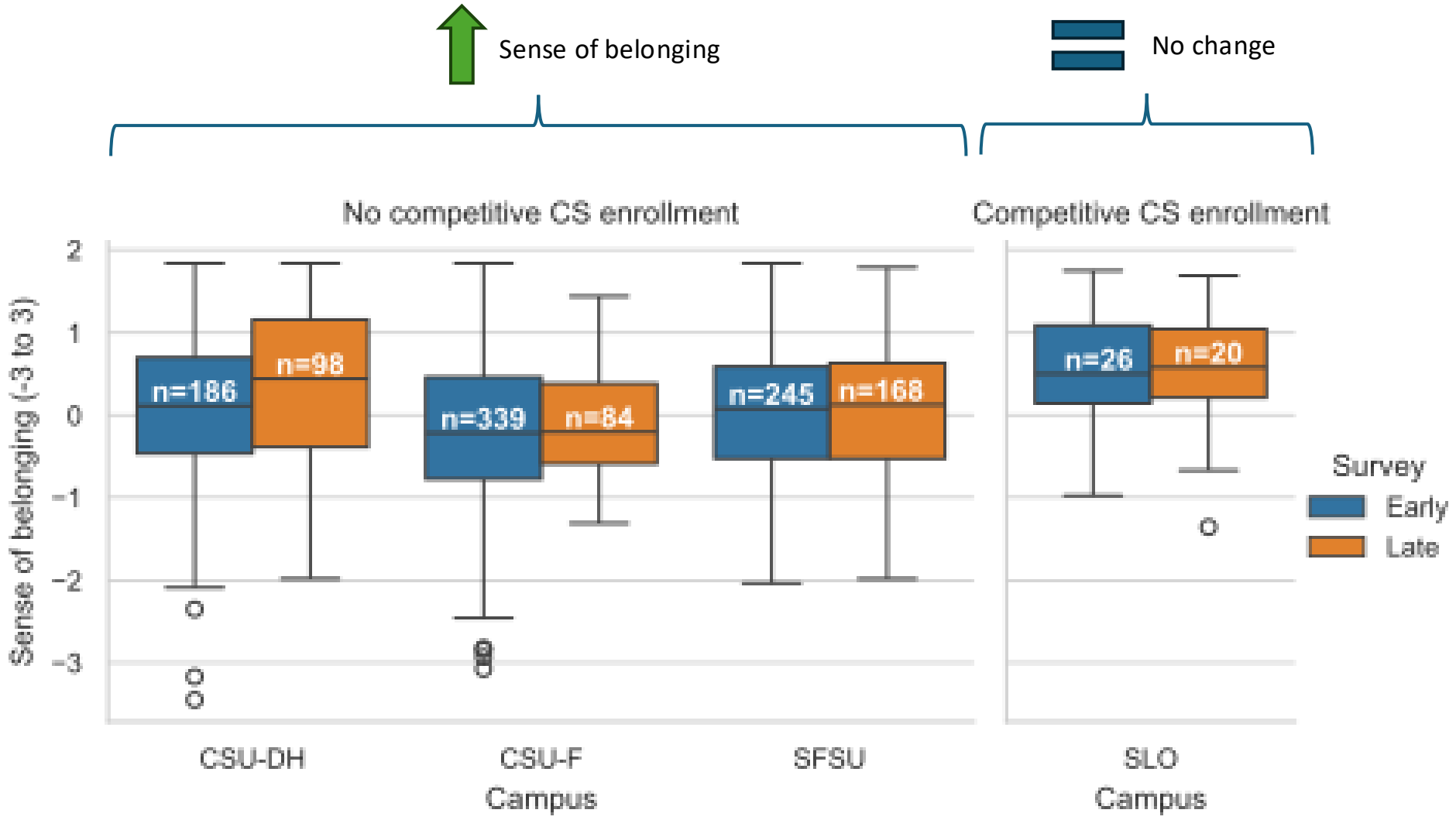
Only courses that had respondents in both groups.

* *Not a pre/post analysis!*



Survey questions source: Moudgalya et al.

Result: Within-Treatment Terms (only CS 0/CS 1)



Note: Sense of belonging scores were adjusted based on a CFA. Details in the paper.

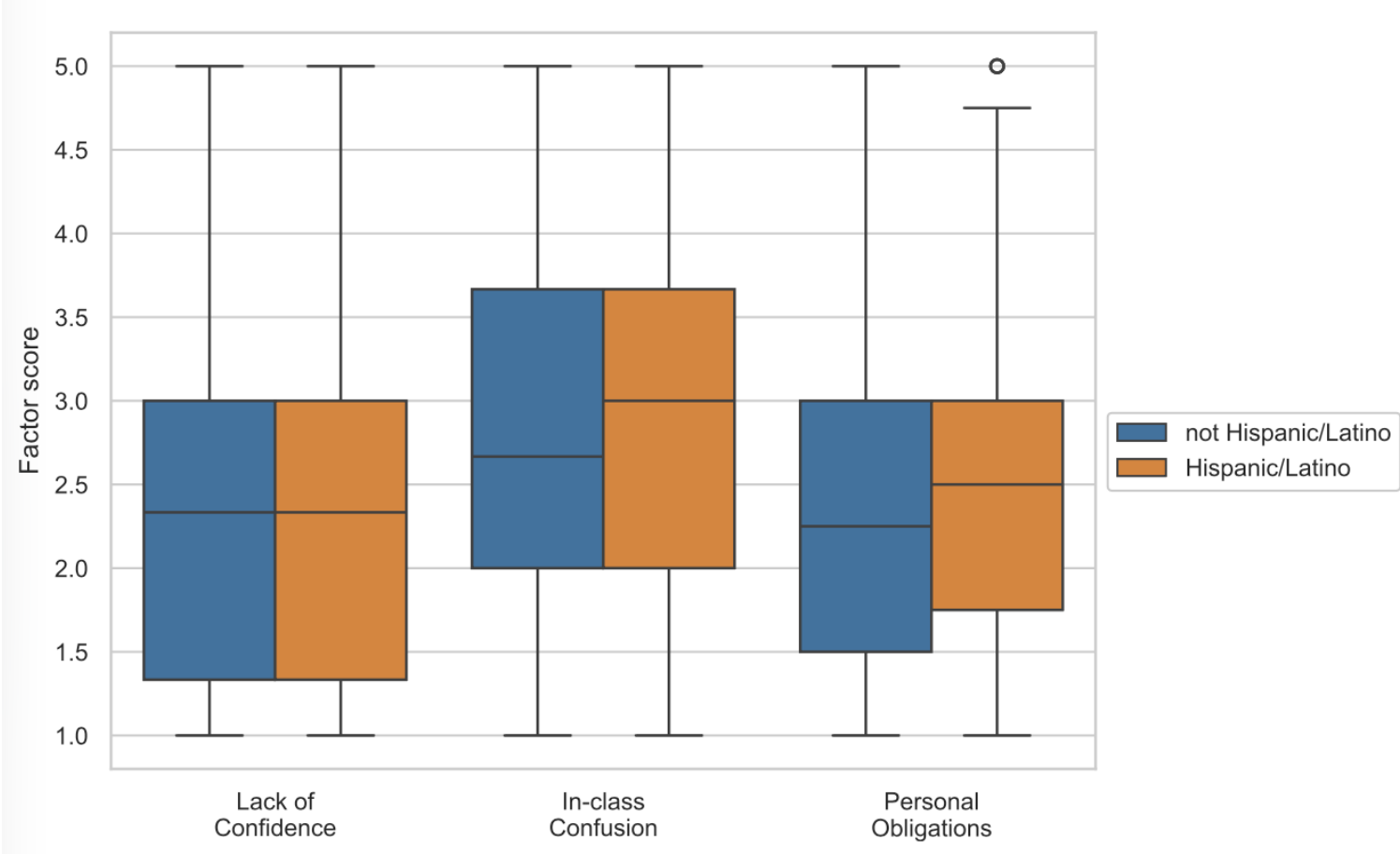
Interference from external factors

Interference from external factors

Hispanic/Latino students were more likely than others to report that **work or family obligations** interfered with their learning.

This effect was **not** present at the two campuses with restrictive enrollments (SLO and Pomona).

(all campuses)



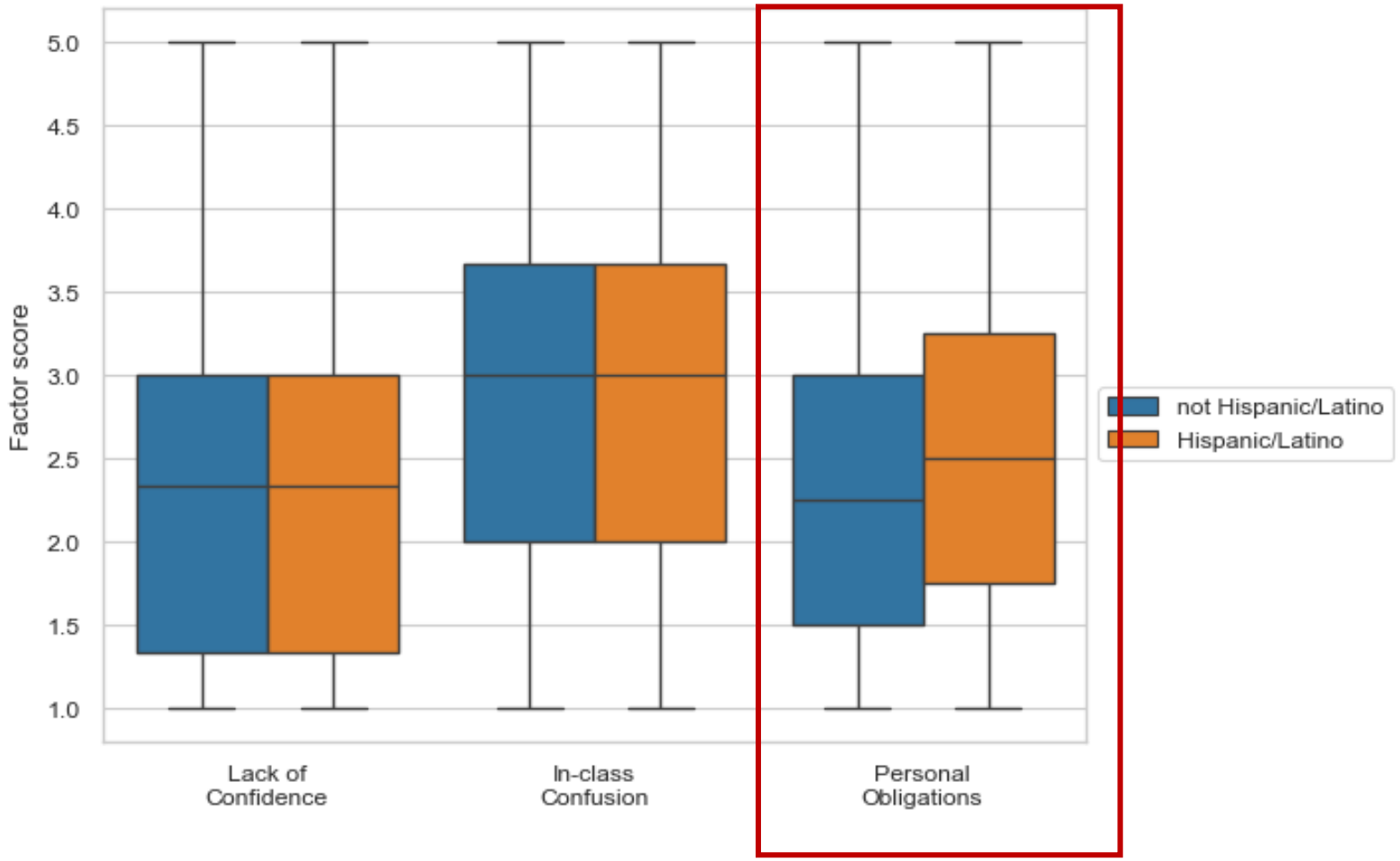
Survey questions source: Salguero et al.

Interference from external factors

Hispanic/Latino students were more likely than others to report that **work or family obligations** interfered with their learning.

This effect was **not** present at the two campuses with restrictive enrollments (SLO and Pomona).

(campuses without restrictive enrollment)



Survey questions source: Salguero et al.

Conclusion

Coursework focused on Socially Responsible Computing was associated with an **increased sense of belonging**...

- …in first-year CS courses
- …at campuses without restrictive CS enrollment policies

Research outcomes were mediated by broader institutional contexts. Variations in campus policies and student experience were mirrored in our results.

Thanks for listening!

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Project website
bpcsrc.org

Extra slides for questions

Data from 2024–2025 (not in paper)

Slight increases evident at CSU-LA and SFSU.

At Cal Poly Pomona, an increase that was not seen in Year 2 data.

As before, no change at Cal Poly SLO.

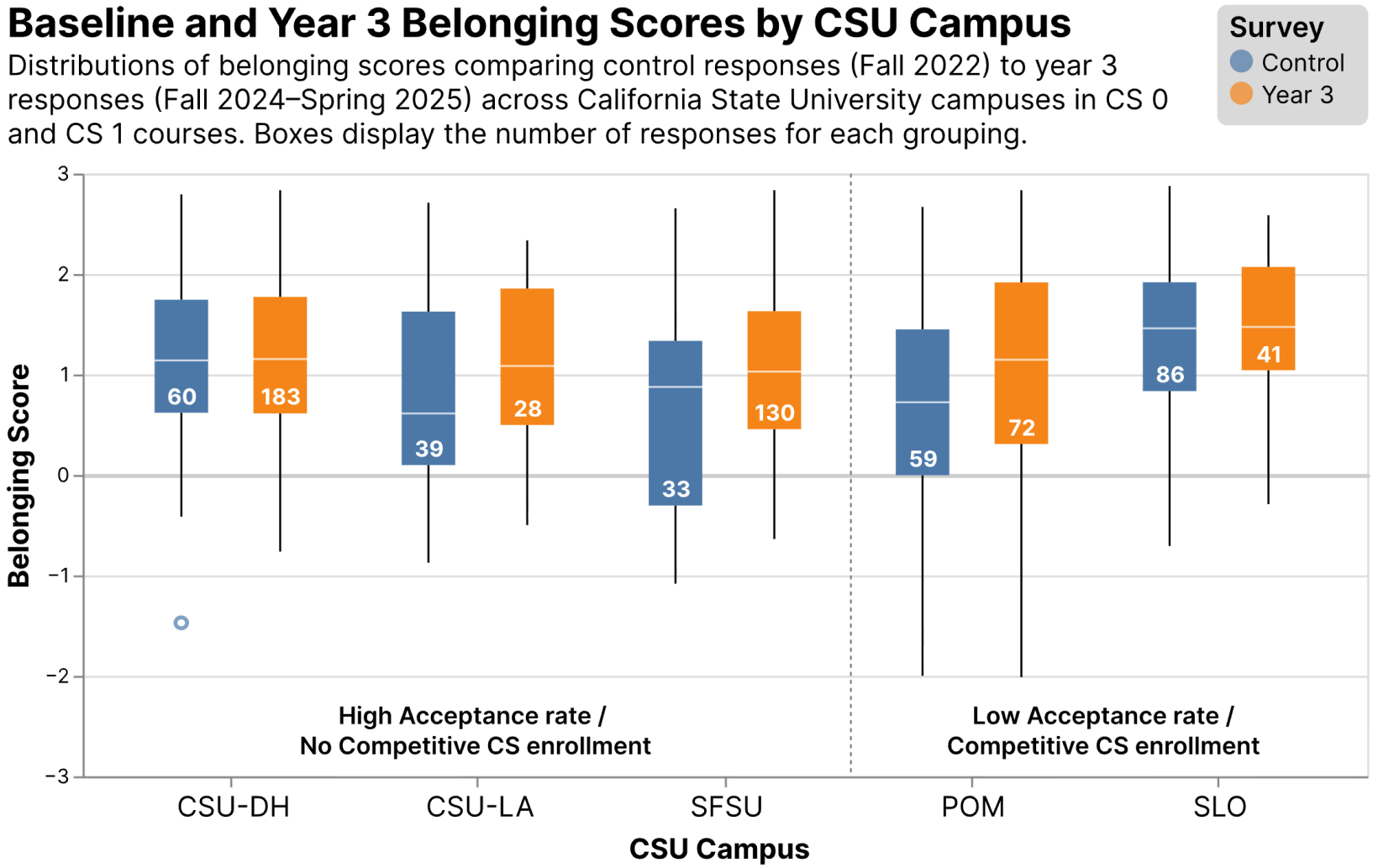

Table 1 — Site variance

	Campus					
Attribute	DH	LA	FULLERTON	SF	*POMONA*	*SLO*
Had pre-college CS education	21%	38%	43%	23%	65%	47%
% Hispanic/Latino (University)	69%	75%	52%	37%	53%	23%
% Hispanic/Latino (CS Majors)	63%	54%	27%	26%	27%	11%
% of students who leave CS who have an "URM" identity	42%	45%	30%	45%	26%	18%
% Receiving Pell grant	61%	66%	47%	43%	46%	18%
% First-generation students	46%	57%	32%	32%	55%	17%
University acceptance rate	86%	91%	59%	93%	44%	33%
Has competitive CS enrollment?	No	No	No	No	Yes	Yes

All sites have between 1,000 and 2,000 CS majors in total. Campuses are identified as having a competitive enrollment policy if their identifiers are *italicised* (i.e., POMONA and SLO). Prior experience in CS was measured through survey questions (Section 5) and may suffer from selection bias. Other attributes are based on institutional data.

To what degree did your assignments or projects help you do the following?

Comparing answers to questions about SRC assignments and non-SRC assignments.

	CS 0 / CS 1 courses	CS 2 courses
Develop technical vocabulary	**SRC**	
Develop programming skills	**SRC**	
Understand how CS can help solve concerns in society	**SRC**	**SRC**
Use real-world data to solve CS problems	**SRC**	**SRC**
Communicate with real community members		**SRC**
Design a CS solution for a real community	**SRC**	**SRC**
Use CS to solve problems you find interesting	**SRC**	
Use CS to solve problems you find interesting Give you choice in what to focus on or how to approach assignments		