

# An Analysis of Stress and Sense of Belonging Among Native and Non-native English Speakers Learning Computer Science

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## ABSTRACT

Previous studies have shown that non-native English speakers (NNES) have lower confidence levels at the beginning of the term and higher academic expectations for themselves throughout the term. Additionally, although non-native English speakers study for longer hours compared to native English speakers (NES), there were not any differences in their grades. To better understand the experiences of NNES learning Computer Science in a U.S. university, we examined possible factors that may contribute to differences in stress and sense of belonging between NES and NNES. From our investigation using weekly surveys, we did not find any significant difference in the stress level reported by NES and NNES. However, we found differences in the factors that contribute to the stress level of NES and NNES. Factors such as ‘personal life’ and ‘requirements for other classes’ were major factors that contributed towards the stress level of NES, whereas ‘embarrassment asking for help’ and ‘self doubt’ were more common among NNES. As for sense of belonging, we found no significant difference between NES and NNES. Additionally, we found that the number of classmates that NES feel comfortable reaching out to is not a factor affecting their sense of belonging in an introductory computer science class.

## CCS CONCEPTS

• **Social and professional topics** → **Computer science education**.

## KEYWORDS

Sense of Belonging; Stress; Sense of Community; Non-Native English Speakers

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## 1 INTRODUCTION

In a world driven by technology, Computer Science is becoming increasingly important in all fields. The growing demand for a technical workforce means there are more students taking Computer Science courses than ever before. A significant portion of these students are non-native English speakers (NNES). However, most of the online learning communities and related documentation are in English [2, 6, 13]. This proves to be a significant disadvantage for NNES studying Computer Science [12, 18–21]. It is important for us to understand the experiences of NNES learning Computer Science in order to build a more supportive and inclusive community for everyone [25–28].

Our paper seeks to expand on a recent study which found that there was a significant difference in the confidence level of NNES and native English speakers (NES) [5]. NNES not only started the term with lower confidence, but also held themselves to a higher academic standard with longer average study time [5]. In order to understand the learning experience of NNES even more, our paper will explore two additional perspectives: stress and sense of belonging.

Many NNES are prone to higher stress and anxiety due to the challenges they face from lack of support, English language proficiency, and cultural differences [3–5, 15]. Studies have also indicated that sense of belonging is crucial for student retention in STEM. It is imperative to build a supportive and inclusive learning environment that values sense of belonging and mental health for everyone. Most existing works examined the correlation between sense of belonging and factors such as race and gender [9, 24, 31]. Little work has been done uncovering the correlation between sense of belonging and native language status.

For the reasons above, we examined the difference between the learning experience of NES and NNES with a focus on stress and sense of belonging. Moreover, we seek to find a pattern in the factors that may correlate with the stress for NES and NNES. We also seek to examine the correlation between sense of belonging and number of classmates students feel comfortable reaching out to.

We analyzed the data collected from the weekly surveys from introductory Computer Science courses at a research-intensive public university in the United States to understand the differences between stress and sense of belonging among NES and NNES. By investigating these differences, our study contributes knowledge to the literature on the barriers that NNES face while learning computing in countries where English is the native language.

Our study aims to answer the following research questions:

- (1) *Is there a difference in stress level between NES and NNES, and what are some factors that are correlated with the stress?*
- (2) *Is there a difference in the sense of belonging between NES and NNES?*
- (3) *Is there a correlation between sense of belonging and the number of classmates students feel comfortable reaching out to?*

## 2 RELATED WORK

Since international students are mostly non-native English speakers (NNES), we believed that work about the experience of international students could exemplify some aspects of NNES. In previous studies that focused on the experience of international students studying at U.S. universities, the majority of international students faces many challenges, such as cultural adjustments, lack of social support, and an unfamiliar educational system [11, 22]. Mori et al. examined the source of mental health concerns for international students and found that English proficiency is the most significant issue for them [15]. Many international students are top academic talents in their native countries and require a higher minimum grade in order to be satisfied [5, 15]. Moreover, a study by Philip Guo found that NNES particularly face many difficulties learning Computer Science, such as reading instruction materials, reading and writing code, and technical communication. Much of the online discussion forums and documentation are only in English and create a significant barrier to learning for these students [4].

Studies have found that lack of English proficiency for NNES can significantly impact their academic performance [12]. In addition, English proficiency is also one of the most common predictors of psychological symptoms among international students [35]. High expectations for academic performance [15] combined with cultural and education barriers have led to higher stress and anxiety reported among NNES [17, 33]. Even though both NES and NNES experience stress in college, different backgrounds and experiences can lead to differences in how they react to factors causing stress [14]. Therefore, in addition to comparing the stress levels of NES and NNES, our study seeks to create a better understanding of their differences by examining the factors that are highly correlated with their stress.

Prior work has shown that groups that are underrepresented in CS feel uncertain of their sense of belonging [31]. Sense of belonging is crucial for retaining and supporting students in STEM, especially those within groups that are underrepresented [24]. A study by LaCosse et al. examined the impact of social-belonging intervention on academic performance in STEM students who speak English as a second language [10]. The study indicated that the students who received intervention have higher academic performance and persistence in STEM than the students who did not. While prior work has investigated the importance of sense of belonging in groups that are underrepresented, not much has been done to understand if the same holds for NNES or whether the difference of native language status has any impact on students' sense of belonging [24, 31]. Given that the lack of social support is a significant contributor to stress [15, 29, 35] and the importance of sense of belonging, our study aims to examine the sense of belonging among NNES compared to NES. Additionally, Walton et

al. examined the sense of belonging of underrepresented groups by asking students to list 2 friends or list 8 friends. While most students had difficulties listing 8 friends, only students who were in minority groups felt a low sense of fit from this exercise [31].

A more recent study by Krause-Levy et al. looked at the sense of belonging in lower division computer science courses and examined the relationship between sense of belonging and retention as well as the course performance of the students [9]. They found that lower sense of belonging was correlated with negative course outcomes in initial course and sense of belonging was not predictive of retention. While their study explored the differences between sense of belonging across gender, race, first generation status and transfer status of students, our study adds value to their results by exploring sense of belonging between native- and non-native English speakers.

## 3 METHODOLOGY

We conducted our study at UC San Diego, a research intensive public university in the United States. Weekly surveys were conducted for introductory Computer Science courses throughout a quarter (10 weeks). The data used in this research was obtained from three lower-division courses from our university in an in-person class environment in Fall 2019 before the COVID-19 pandemic.

The three lower-division CS courses in which we conducted our study are as follows:

- (1) **CS1:** This is a Computer Science course designed for students with no prior programming experience taught as the first part of the two-course introductory programming courses (CS1 and CS1.5). This course is taught in Java. We excluded CS1.5 because more than half of the survey data was missing for this course.
- (2) **CS1A:** This is an accelerated version of the combination of the two introductory programming courses (CS1 and CS1.5). This course is taught in Java.
- (3) **CS2:** This is a Computer Science course that students take after familiarizing themselves with the basics of programming. This course focuses on basic data structures and is taught in Java.

On an average, in CS1, 257 NES and 186 NNES responded to the surveys. In CS1A, the number of NES and NNES that responded to the surveys were 258 and 80 respectively. In CS2, the number of respondents in each category were 91 and 82 respectively.

### 3.1 Description of Survey Collection

Before the start of each of the three courses, a pre-survey was conducted to learn about students' prior Computer Science experience and their native language status along with some general information. The presurvey can be found here: <https://forms.gle/Z6HrDgBeNjgiiE699>. All students were informed about this research study and were asked for their consent to participate in this research study. They were asked to fill out the surveys after they completed each week's programming assignment. The surveys themselves were also a part of the weekly assignments. Students were awarded a small amount of credit for filling out the survey that counted towards their assignment grade in order to incentivize the completion in all the three courses. We believed that asking

students to complete the survey every week after the completion of their assignment could give us a more accurate picture of the students' experience during that week. The number of surveys collected each week fluctuates as some students forgot to turn in their survey responses. All survey data was deidentified before it was used for our data analysis. The surveys were conducted for 8 weeks in CS1 and CS1A and for 10 weeks in CS2. The weekly survey can be found here: <https://forms.gle/rxWeAzms2mNMJU67>

**Native Language Question:** We asked the following question about students' native language status in the pre-survey.

*What is your fluency with English?* The students were given the following four choices: (1) I learned English as a child as my primary language. (2) I learned English as a child in a bilingual or multi-lingual setting. I am equally comfortable in English and another language. (3) I learned English after learning another primary language and I am equally comfortable in both languages. (4) I learned English after learning another primary language and I am not as comfortable in English as I am in another language. We categorized students who responded 1 or 2 to be NES because they learned English as their primary language. Accordingly, we categorized students who responded 3 or 4 to be NNES because they learned English after learning another language.

**Stress Related Questions:** The following set of 5-point Likert scale questions were asked in the weekly surveys: (1) *Reflecting on the last week, how stressed have you been overall?* The stress level was an ordinal variable on a Likert scale from 1 to 5, where 1 represents 'Not stressed at all' and 5 represents 'Extremely stressed'. (2) *How challenging was the work for this class this week?* The challenge level was an ordinal variable on a Likert scale from 1 to 5, where 1 represents 'Not at all challenging' and 5 represents 'Extremely challenging'. (3) *In the past week, on a scale of 1 to 5, to what degree did each of the following interfere with your ability to learn and complete the work for this course?* (a) Requirements for other classes (b) Illness (c) Family obligations (d) Work obligations (e) Social/personal life issues (f) Confusion specifically about the assignment (g) Confusion generally about the material (h) Getting stuck on a bug (i) Inability to get help (j) Embarrassment/discomfort asking others for help (k) Self-doubt/lack of confidence (l) Lack of interest in the assignment or material (m) Goofing off/procrastination (n) Other. (4) *What is your current overall satisfaction with your performance in this class?* The satisfaction level was an ordinal variable on a Likert scale from 1 to 5, where 1 represents 'Not satisfied at all' and 5 represents 'Extremely satisfied'.

**Sense of Belonging Related Questions:** The questions used to measure the sense of belonging have been adapted from the work of Sax et al. [24], investigating the sense of belonging in groups that are underrepresented in computing. In every weekly survey in the three courses, students were asked the following questions:

- (1) Reflecting on your experiences over the past week, to what extent do you agree with the following statements:
  - (a) I feel accepted in this class.
  - (b) I feel comfortable in this class.
  - (c) I feel supported in this class.
  - (d) I feel like I don't belong in this class.

All the items above were scored using a 5-point Likert scale ranging from 1 (*Not at all*) to 5 (*Completely*).

- (2) At this time, approximately how many other students in this course would you be comfortable reaching out to study with?

## 3.2 Description of Data Analysis

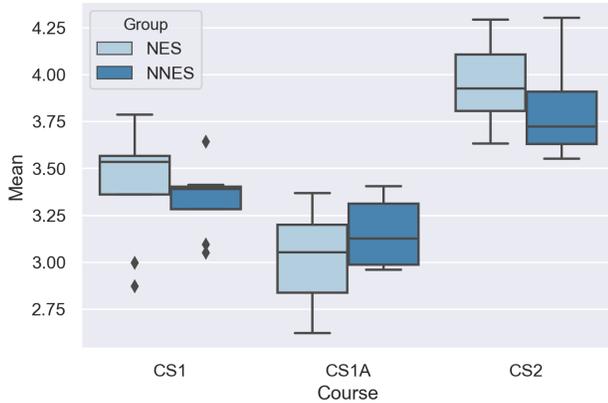
Before analyzing the data, we dropped all the data related to students who did not consent for participation or were minors (below 18 years of age). In addition, we removed all weekly survey responses from students who did not fill out the pre-survey as we did not have information about native language status. After these modifications, each response to the weekly surveys could be categorized as native English speakers (NES) or non-native English speakers (NNES) based on the pre-survey.

**3.2.1 Data Analysis for RQ 1.** In order to answer the question whether there is a difference in stress level between NES and NNES, we performed Mann-Whitney U tests for each week on the stress data. Mann-Whitney U test was selected due to its nonparametric quality as we did not want to make the assumption that the interval between each adjacent values of an ordinal variable is constant. Additionally, we applied Bonferroni correction in order to address the multiple comparisons problem from doing Mann-Whitney U tests for each week as multiple analyses were conducted on the same dependent variable. Thus, an alpha value of 0.05 divided by the number of weeks was used to determine the significance ( $\alpha = 0.00625$  for CS1 and CS1A,  $\alpha = 0.005$  for CS2).

Next, we investigated different factors that contribute to the stress of NNES and NES. We performed ordinal logistic regression between the stress and different contributing factors for all weeks. Since the dependent variable stress is an ordinal variable, we used this regression to reveal the strength of correlation between the stress and those factors. All ordinal logistic regression analyses were performed using IBM's Statistical Package for the Social Sciences (SPSS). From this we were able to identify which factors were significantly correlated to stress. We also applied Bonferroni correction here due to the same reasons mentioned above.

**3.2.2 Data Analysis for RQ 2.** We performed Mann-Whitney U tests individually on each week's data for each statement shown under the sense of belonging question under Section 3.1 to find if there is any difference in the sense of belonging between NES and NNES for that week. Then, we applied the Bonferroni correction ( $\alpha = 0.00625$  for CS1 and CS1A,  $\alpha = 0.005$  for CS2).

**3.2.3 Data Analysis for RQ 3.** We used Kendall's Tau test to see if a correlation exists between the sense of belonging and the number of classmates students feel comfortable reaching out to. We chose Kendall's Tau test because the dependent variable sense of belonging (accepted, comfortable, supported, and non-belonging) was an ordinal variable and the independent variable was continuous. Then, we applied the Bonferroni correction ( $\alpha = 0.00625$  for CS1 and CS1A,  $\alpha = 0.005$  for CS2). In the interest of the length of this paper, we only report the minimum and maximum values of the correlation coefficient of the weeks that were found to have a significant correlation as the analysis was done for each week of each course separately.



**Figure 1: The box plot shows the distribution of student responses used to measure students' stress across the three courses over the entire quarter for NES and NNES.**

## 4 RESULTS

### 4.1 Is there a difference between the stress level of NES and NNES? What are the factors that are correlated with stress?

We performed the Mann-Whitney U test for all the weekly data separately for each course to see if there is any significant difference between the stress levels of the two groups. After applying Bonferroni correction in order to address the multiple comparisons problem, the adjusted alpha values are 0.00625 for CS1 and CS1A which contains eight weekly surveys and 0.005 for CS2 which contains ten weekly surveys. As shown in Figure 1, Native English speakers (NES) reported higher average stress than non-native English speakers (NNES) in CS1 ( $mean_{NES} = 3.41, mean_{NNES} = 3.34$ ) and CS2 ( $mean_{NES} = 3.95, mean_{NNES} = 3.79$ ) while NNES reported higher stress than NES in CS1A ( $mean_{NNES} = 3.15, mean = 3.02$ ). However, the difference in stress between NES and NNES is not significant for any week in all the three courses.

Factors	No. of Sig. Weeks		Avg. Odds Ratio	
	NES	NNES	NES	NNES
Difficulty of class	20	25	2.9935	5.3208
Requirements for other classes	20	8	1.7769	1.5447
Social/Personal Life Issues	3	0	1.3752	1.2541
Embarrassment asking others help	0	2	1.1038	1.8104
Self-Doubt	0	2	1.2378	1.7932
Overall Satisfaction	6	5	0.729	0.6021

**Table 1: Table of factors that has more than 1 week that are significantly correlated with stress of NES and NNES**

Next, we took a closer look at what factors were correlated to the stress levels of NES and NNES. We performed ordinal logistic regression on the ordinal dependent variable stress with the 14 factors (see Section 3.1) as covariates. The coefficients from the model can be somewhat difficult to interpret because they are scaled

in terms of log. As the coefficients from the regression are on a logarithmic scale, we converted the coefficients to odds ratio so that it is easier to understand. The results are summarized in Table 1.

For both CS1 and CS1A, 'difficulty of class' was a significant factor every week for both the groups. However, for CS2, we saw that 'difficulty of class' was a significant factor for stress for four weeks for NES and nine out of ten weeks for NNES. We saw a higher odds ratio for NNES, meaning there would be a greater increase in the stress level of NNES with the same unit increase in the 'difficulty of class' compared to NES. Aside of 'difficulty of class', the factor 'overall satisfaction for class' was also significantly correlated for both NES and NNES. 'Requirement for other classes' is also a significant factor of stress for NES for almost every week and around a third of all weeks for NNES. Factors that are only significantly correlated to NNES are: 'embarrassment asking for help', and 'self-doubt'. 'Social/Personal Life' were only significantly correlated for NES.

### 4.2 Is there a difference in the sense of belonging between NES and NNES?

For all the three courses, since the data is ordinal, we conducted the Mann-Whitney U test on all the weekly survey data to find differences between NES and NNES with respect to their sense of belonging for all the three courses. Since there was a multiple comparisons problem, a Bonferroni correction was applied and the alpha value was adjusted to 0.00625 for CS1 and CS1A and 0.005 for CS2.

Figure 2 shows the box plot of sense of belonging among NES and NNES across all weeks in the three courses. There was no statistically significant difference between NES and NNES for the following four survey items: 1) I feel accepted in this class, 2) I feel comfortable in this class, 3) I feel supported in this class, and 4) I feel like I don't belong in this class. However, in CS1A, NES reported a higher sense of non-belonging, or feeling as if they do not belong in the class, compared to NNES in the third week of the course ( $U = 8729, p = 0.001, r = 0.2$ ), but in other weeks of CS1A, the difference was not significant.

### 4.3 Is there a correlation between sense of belonging and the number of classmates students feel comfortable reaching out to?

We conducted a Kendall-Tau test [23] on all weekly survey data because the dependent variables of sense of belonging (accepted, comfortable, supported, and non-belonging) are ordinal variables and the independent variable is continuous. This test was used on all the weeks of the three courses for NES and NNES to find the correlation between the number of classmates a student feels comfortable reaching out to and their sense of belonging. We report the results for the weeks that were significant in each course, i.e., the p-value is less than the alpha value. The results are as follows:

For NES in CS1, starting from the second week, the correlation between the number of classmates students feel comfortable reaching out to and the feeling of both accepted and comfortable is positive and statistically significant, but the correlation is weak [comfortable ( $\tau_{min} = 0.15, \tau_{max} = 0.26$ ), and accepted ( $\tau_{min} = 0.16, \tau_{max} = 0.25$ )]. Similarly, the correlation between the

number of classmates NES feel comfortable reaching out to and the sense of feeling supported is low ( $\tau_{min} = 0.15$ ,  $\tau_{max} = 0.22$ ), positive and statistically significant for all the weeks in the course except the first week and the seventh week. In those two weeks, the correlation is not significant. Contrary to this, NES show weak negative correlation between the sense of non-belonging and number of friends they feel comfortable reaching out to only in the mid four weeks ( $\tau_{min} = -0.14$ ,  $\tau_{max} = -0.13$ ). However, the correlation between the number of classmates students feel comfortable reaching out to and the factors of sense of belonging (acceptance, support, comfort, non-belonging) among NNES is not significant throughout CS1.

In CS1A, the correlation between the number of classmates a student feels comfortable reaching out to and each factor of sense of belonging for NES and NNES are the following. For the factor of feeling accepted, the correlation is positive and statistically significant for all eight weeks for NES ( $\tau_{min} = 0.14$ ,  $\tau_{max} = 0.30$ ) and only three of the total weeks for NNES ( $\tau_{min} = 0.30$ ,  $\tau_{max} = 0.35$ ). Similarly, for feeling supported, the correlation is positive and statistically significant for all eight weeks for NES ( $\tau_{min} = 0.17$ ,  $\tau_{max} = 0.30$ ) and only four weeks for NNES ( $\tau_{min} = 0.26$ ,  $\tau_{max} = 0.34$ ). As for feeling comfortable in the course, the correlation is positive and statistically significant for all eight weeks except week 3 for NES ( $\tau_{min} = 0.22$ ,  $\tau_{max} = 0.31$ ) and only two weeks for NNES [W4 ( $\tau = 0.33$ ), W7 ( $\tau = 0.29$ )]. However, for the feeling as if they do not belong in the course, the correlation is negative and statistically significant for all eight weeks except week 3 for NES ( $\tau_{min} = -0.25$ ,  $\tau_{max} = -0.14$ ) and only two weeks for NNES [W4 ( $\tau = -0.29$ ), W7 ( $\tau = -0.26$ )]. For both NES and NNES, all statistically significant correlations between number of classmates a student feels comfortable reaching out to and each factor of sense of belonging were weak.

In CS2, only two weeks show a significant positive correlation between the number of classmates students feel comfortable reaching out to and feeling accepted for NES and NNES. However, the correlation for both groups is low: NES [W4 ( $\tau = 0.23$ ), W10 ( $\tau = 0.25$ )] and NNES [W2 ( $\tau = 0.28$ ), W5 ( $\tau = 0.34$ )]. While NNES showed no significant correlation between the number of classmates students feel comfortable reaching out to and feeling comfortable in the class, NES showed a significant low positive correlation for four out of ten weeks [ $\tau_{min} = 0.22$ ,  $\tau_{max} = 0.27$ ]. NNES, on the other hand, show a significant low positive correlation between the number of classmates they feel comfortable reaching out to and feeling supported for a couple of weeks in the course [W2 ( $\tau = 0.28$ ), W8 ( $\tau = 0.33$ )]. There was no significant correlation for NES throughout the ten weeks. While NES do not show any correlation between sense of non-belonging and number of classmates they feel comfortable reaching out to, NNES show a weak negative correlation [W2 ( $\tau = -0.29$ )].

## 5 DISCUSSION

### 5.1 Interpretation of Results

Our study tried finding if there is any significant difference in the stress level reported by native English speakers (NES) versus non-native English speakers (NNES) in introductory CS classes. We did not find any significant difference between the two groups in any

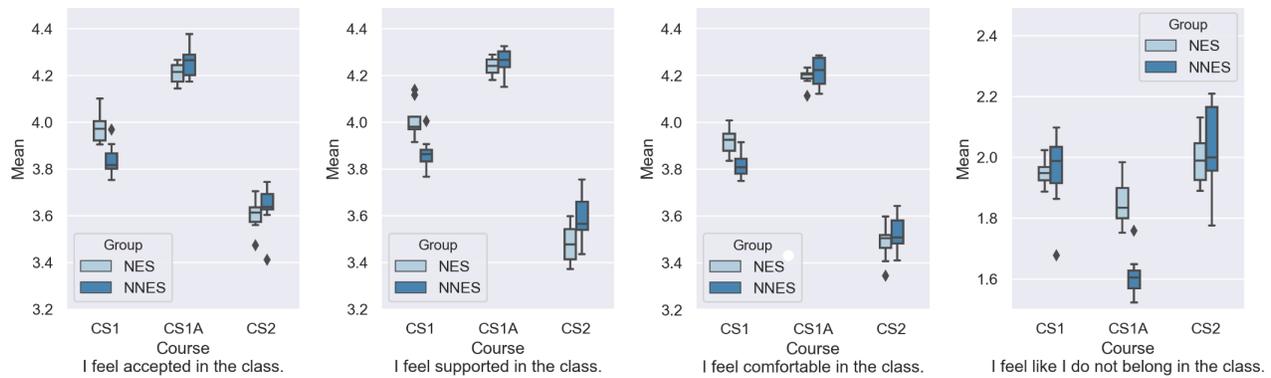
week of the three courses. A possible explanation for this is that the environment created in the lower division CS classes at UC San Diego is inclusive for all students, irrespective of their English language fluency. In CS1A, the average stress was higher in NNES than NES throughout the course. Although the difference is not significant, a possible reason might be that NNES are more stressed because they have higher grade expectations in CS courses than NES [5].

Among the factors that were correlated with stress, we found that the 'difficulty of the class' was a significant factor among NNES in CS2 for most of the weeks. This might be because NNES experience higher cognitive load while learning difficult CS concepts [4]. Additionally, the factor 'social/personal life' was significant among NES while not for NNES. Our results contradict with prior studies that report some NNES faces higher acculturative stress [34] and alienation [8]. However, we suspect that the reason NNES did not report 'social/personal life' as a significant factor is because Asians, who are a large majority of NNES at UC San Diego [1], are less likely to admit social/emotional concerns [30]. In CS1A, NNES also experienced 'embarrassment asking for help' and 'self-doubt' to the extent that those factors significantly affected their stress level. Our results match with a prior study that reported NNES may not have a support system that they are familiar with and felt embarrassed asking for help in a new environment [32].

We found that there was no significant difference in the sense of belonging between NES and NNES across all the three courses (see Section 4.2). Although NES reported a higher average sense of belonging than NNES in all four factors (Accepted, Comfortable, Supported, Non-Belonging) in CS1, the difference between the two groups was not statistically significant. A possible interpretation might be that the pedagogical techniques and course resources (e.g., office hours, lecture recordings, worksheets, weekly survey) in these courses are designed with the intent to make all students feel comfortable and belonged in the classroom and were successful. In CS2, NNES on average reported a higher sense of belonging than NES although the difference was not significant. This might be due to the fact that students usually take these courses during their second or third quarter in school. By that time, NNES feel more accepted and belonged as they may have become more familiar with the course structure and formed study groups with other students. Our results match those observed by Moudgalya et al. in which there was no difference between the sense of belonging measured at the factor level between Process Oriented Guided Inquiry Learning (POGIL) classrooms and non-POGIL classrooms [16].

Our results showed that NES mainly have a weak correlation between number of classmates they feel comfortable reaching out to and each factor of sense of belonging in CS1 and CS1A and almost no correlation in CS2 (see Section 4.3). A possible interpretation is that NES were more active in connecting with classmates in these CS courses due to CS1 and CS1A typically being the first introductory CS courses students take. As they become more aware of class resources, they may depend on these resources instead of their classmates, possibly leading to the change from weak correlation in CS1 and CS1A to no correlation in CS2.

Some NNES, specifically international students, tend to struggle with not only academic but also social and cultural barriers as well due to language [32]. Therefore, a possible interpretation for the



**Figure 2: The box plot shows the distribution of student responses for the four factors (‘Accept’, ‘Comfort’, ‘Support’, ‘Non-Belonging’) used to measure students’ sense of belonging across the three courses over the entire quarter for NES and NNES. Note that the y-axis range of the right most box plot is different than the other three for better visualization.**

lack of any correlation between the number of classmates they feel comfortable reaching out to in the course and sense of belonging in CS1 is that NNES have a strong support network outside of the course that better understands their language struggles. The weak correlation in CS1A and CS2 mainly occurred in weeks near midterm exams. NNES who may typically only depend on class resources may also join study groups with classmates for these exams, possibly leading to a higher correlation between the number of classmates they feel comfortable reaching out to in the course and sense of belonging than usual.

### 5.2 Limitations and Future Work

We grouped students based on self-reported language proficiency and did not factor in their race, nationality, or gender. Generalizations were made based on whether the student learned English as their first language. More specific categorization might benefit and deepen the understanding of every individual survey response. Additionally, in our survey, we only asked students for number of classmates they feel comfortable reaching out to. Thus, our research did not account for external support outside of the course.

Generalizations were also made in regards to the statements such as ‘I feel supported in this class’. We did not specify what kind of support and that may have potentially limited our understanding about the situation when one group of students felt less supported. Prior work practiced specifying whether the support was from the department or from other individuals in the class [24]. We did not give instructors any suggestions about how to make NNES feel more supported or belonged as that was not the goal of our survey. Nevertheless, we do suggest future work to provide more detailed and specified statements in the surveys in order to have a more thorough understanding about what makes students feel more or less belonged in computing classrooms.

Our study was conducted in an English speaking university in the United States. Future work could consider Computer Science courses taught in non-English speaking countries which could yield different results. Additionally, our study categorized native and non-native English speakers based on their self reported fluency in English and their first language. Future work could consider different approaches such as grouping students based on their nationality, immigration status, etc.

Our study only looked at three courses in one academic term. We were unable to conclude whether the phenomenon we noticed symbolized a trend. We would suggest future studies follow one specific group of students as they progress through higher level CS courses or examine the same course in multiple terms to discover a more general trend.

Given that prior work has shown that lack of social support is a significant contributor of stress for NNES and that our study found that ‘self-doubt’ and ‘embarrassment asking for help’ are the two significant factors that correlated with the stress for NNES, we invite future work to investigate the NNES stress coping mechanisms as well as resources that NNES use when compared to NES. Lastly, future work could also investigate different levels or types of support provided in class as predictors of NNES stress.

Numerous factors in different categories could correlate to the sense of belonging and our study only examined a handful. Prior work concluded that the students’ involvement and membership in school highly correlates with their sense of belonging [7]; however, our survey did not cover those areas. For future work we suggest a wider range of information about the students to be collected from both NES and NNES. More observation about the involvement of NNES in school and the link to their sense of belonging can be discovered. We invite future work to host interviews with NNES in order to further understand the barriers that they may face while learning computing at a U.S. university.

## 6 CONCLUSION

In conclusion, although there was no significant difference in the stress level between native English speakers (NES) and non-native English speakers (NNES), there was a difference in the underlying factors that were correlated with stress for NES and NNES. We also found that NNES were more likely to report ‘self-doubt’ and ‘embarrassment asking for help’ when compared to NES. Additionally, no correlation was found between the sense of belonging and number of classmates NNES feel comfortable reaching out to. We conclude that more work needs to be done in order to fully understand the experiences of NNES in a U.S. university and whether they truly feel belonged in the CS community. We invite more work to focus on the experience of NNES, so we can build a community that is inclusive and supportive for all CS learners.

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