

Why Do Students Leave Your CS Program? A Free Evidence-Based Survey to Identify Causes of Attrition in Your Department

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Abstract

Computer science faculty are concerned with retaining students who are admitted into their postsecondary programs of study. Some students leave because their interests change, but others leave for structural reasons that could be addressed by faculty. For example, students may leave because of unbalanced workloads, poor social climate among students, assignments that seem to have no personal relevance, or other issues that can be remedied. An exit survey can give departments actionable evidence about what makes their students leave, including whether some groups of students are more likely to leave than others. Not only can a department benefit by routine formative evaluation, it can benefit by allowing students' voices to be heard, implicitly communicating care for students' experiences. In this paper, we introduce an evidence-driven exit survey that undergraduate computing departments can adapt to encourage feedback from CS leavers. We present our development methodology alongside proof-of-concept data to demonstrate the nature of results and the implications for a department that adopts this tool.

CCS Concepts

• **Social and professional topics** → *Computing education*; • **Social and professional topics** • **Computer science education**;

Keywords

attrition, exit survey, retention, undergraduate, tools

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1 Introduction

A significant issue in postsecondary computing education in the past decade is managing enrollment growth [12, 23]. With enrollment growth, resources such as faculty, advising staff, and classroom space are spread more thinly across the student population [11]. To that end, the higher than average program attrition among

CS undergraduates might seem welcome [25]. However, studies have shown that students who are historically underrepresented in computing by gender, race, and ethnic identity are retained at lower rates [15, 23, 25].

Any degree program naturally experiences some level of attrition as their students gain a better understanding of their own academic and career interests. Still, many computer science leavers report factors beyond disinterest in computing as significant contributors toward their decision to leave [4, 6, 16, 21]. At many institutions, leaving a program is as simple as filling out a web form. Students often go through this process fully disconnected from their departmental staff, providing no opportunity for active feedback or discussion before the student moves on to their future endeavors.

In this paper, we present a free, open survey that serves as a diagnostic tool for undergraduate computing departments to better understand why students are leaving *their* CS program. Understanding students' reasons for leaving is a powerful means to identify strengths and weaknesses local to your department's programs and community. Our exit survey provides a safe forum for CS leavers to quickly and openly express their feelings and concerns to departmental leadership. Some infrastructural problems will be easy to address, and some will be difficult. Acknowledging them can be an important step toward creating a more equitable and inclusive experience for all students.

Below, we provide a very brief summary of retention scholarship, followed by description of data that informed the survey contents, followed by the survey's design and development process. Then, to illustrate the use and usefulness of the survey, we present results from a pilot study of 45 respondents. That is, the pilot is intended only as an example of how a department might use the survey instrument to diagnose local conditions.

2 Retention Scholarship

Scholarship on postsecondary attrition generally defines "retention" and "persistence" as related but distinct concepts. Retention describes what an institution can do to keep students from leaving, while persistence describes individual students' will and ability to complete their studies [14]. Theoretical frameworks have broad empirical support for explaining student attrition. The most influential theories of retention are Tinto's Interactionist Theory and Astin's Inputs-Environments-Outcomes model [1, 2, 24]. The models combine aspects of student background over which faculty have little control (e.g., identity, socio-economic factors like precollege experience and preparation, personal expectations of performance and outcomes, and others) and institutional factors (e.g., size, specialization, classification, selectivity, cost of tuition, and financial aid distribution). Also important are a student's social experiences,



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such as whether they can form meaningful friendships and a sense of belonging [10]. In science, technology, engineering, and mathematics (STEM) disciplines, many studies have confirmed these factors. For example, [21] and [22] showed that beyond pre-college preparation, students leave because of poor teaching, heavy or unbalanced workload, poor advising, and desire to get away from competitive STEM cultures. Studies in CS have identified similar reasons for staying or leaving, emphasizing student-faculty and student-student interaction, academic involvement, and whether the content of instruction is personally relevant to students as important local factors [4, 5, 9, 18]. However, multi-institutional studies may or may not have external validity for specific CS departments. Further, with limited resources to enact change, it is critical that departments understand which issues to prioritize. The value of knowing the local factors leading to student attrition in CS is illustrated in [8], who used survey results as diagnostic and proposed locally-relevant solutions. Our exit survey aims to provide a simple and inexpensive means for any institution to conduct a similar localized analysis of retention factors.

3 Survey Design: Data and Construction

3.1 Thematic Analysis

We summarized the existing literature relevant to CS in particular (e.g., [4, 18]), and incorporated relevant survey items. We also included factors discussed in our own recent qualitative study of 40 first-year women computer science students' experiences with other students and in classes¹. The women, all still enrolled in their CS programs, expressed a variety of reasons they had thought about leaving the program for other fields. Using inductive thematic analysis, we identified key themes including classroom culture, teaching practices, interest in and enjoyment of the required courses, subtle gendered and racial bias, and social community. For many students, these factors were cited as influential on their decisions to stay in or leave CS.

3.2 Survey Construction and Validation

Our survey was designed based on best practices as described in [13]. The development of survey items stemmed from the literature and the themes emerging from the interview study. These items were iteratively improved through several rounds of revisions and pilot studies. In addition to the survey items themselves, the survey maximizes benefits and minimizes costs for responding to the survey. We strategically designed the survey to reduce the effort and time needed to complete the survey and maximize respondents' willingness to complete it. Our design decisions include extensive branching logic to ensure that the respondent only sees sections relevant to their situation, avoids required responses wherever possible, avoids language that carries stigma or implies judgment, and includes only one open-ended question at the very end of the survey. Because of its availability at our institution and its range of features, we chose Qualtrics as our survey platform [19]. We then turned to survey validation using pilot studies with authentic members of the target audience, students who had left CS programs.

¹The results of this study are not yet published.

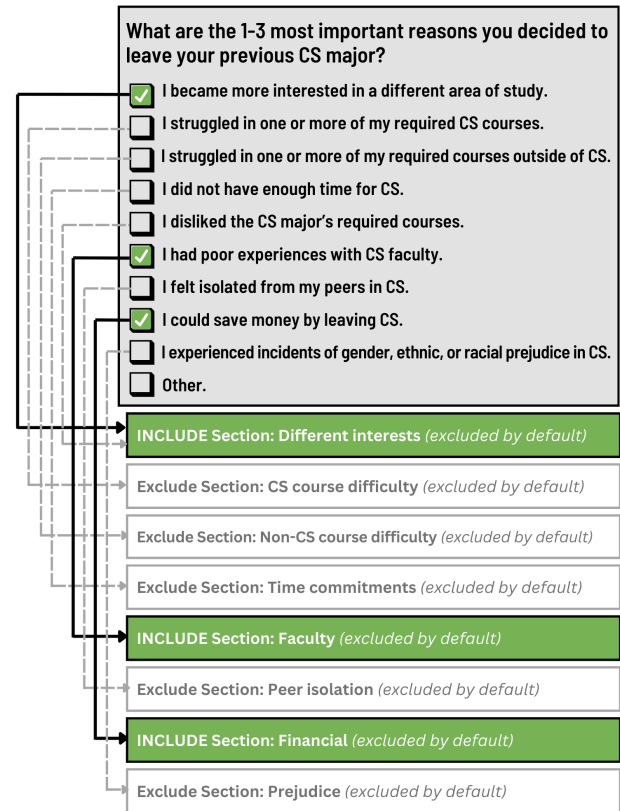


Figure 1: Example Survey Flow Based on Reasons Selected

The first pilot was conducted with four students who had left computer science using a cognitive think-aloud approach [17]. Participants described their response choices as they made them, how they understood the survey items and response categories, and points of confusion. This initial pilot revealed several questions where respondents wanted additional answer options to better capture their personal situations. Based on this feedback, we modified the survey. The second pilot study sampled 25 CS students who had left. With this sample, we gained a few more response categories by asking respondents to evaluate the completeness and relevance of the survey in "Other" text entry fields for the survey items. With these small edits, we finalized the draft used for the final pilot, which is presented in Section 5 of this paper.

3.3 Survey Features & Duration

The survey's branching and logic streamline students' experiences of the survey without compromising the potential richness of the data collected. Respondents only see the content relevant to them based on their responses; the other parts of the survey are invisible to them. The first two questions presented to respondents are branching questions: 1) The first asks about the respondent's "next steps" after leaving CS. This question directs which questions will be asked in three subsequent survey sections, as described in Section 4.1 Survey Introduction below. 2) Respondents are also asked to indicate their top one, two, or three reasons for deciding to leave

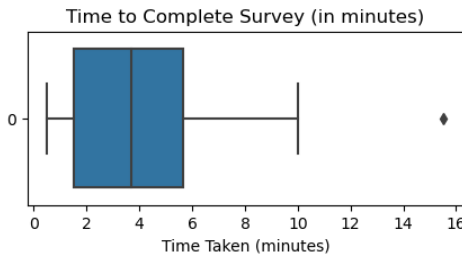


Figure 2: Distribution of Time Needed to Complete the Survey (in minutes)

Table 1: Future Plans & Corresponding Survey Sections

Q5 Answer Selection	Included Survey Sections
"To change to a different field of study at the same institution."	New Field of Study (See 4.2.1)
"To transfer to a different institution and continue computer science studies there."	New Institution (See 4.2.2)
"To transfer to a different institution and pursue a different field of study."	New Field of Study (See 4.2.1) and New Institution (See 4.2.2)
"To leave or take a break from higher education."	Withdrawing (See 4.2.3)

CS from a multiple-selection list. Nine options are presented, as well as an "other" field, that map to eight unique sections in the survey. As soon as the user submits the survey page with their reasons for leaving, the software determines the user's path through the survey, choosing to include or exclude sections. The chart of logic mapping each possible answer to one of the eight sections, as well as an example of a respondent's possible selections and the resulting survey path, can be seen in Figure 1.

Another core feature of this survey is its quick completion time. Following survey guidelines in [13], our original target duration was between five and seven minutes. With our most recent pilot group of 45 respondents (see Section 5), we found that, for the individuals who completed all sections of the survey provided to them, the median survey duration was just below four minutes. This distribution is shown in Figure 2. Survey duration is an essential figure to consider when trying to increase your response rate. Despite having roughly 60 survey items in the full survey, our embedded branching logic streamlines relevant questions so that respondents can easily complete it in one sitting.

4 Overview of Survey Contents

4.1 Survey Introduction

The introduction page collects information on the respondent's duration of enrollment in the CS program as well as the information about their plans after leaving and reasons for leaving to determine the survey's branching.

4.2 Future Plans

The following survey sections are hidden by default and included based on the respondent's answer to Q5, "What is your plan after leaving the CS program?", as illustrated in Table 1.

Table 2: Reasons & Corresponding Survey Sections

Q6 Answer Selection	Included Survey Section
"I became more interested in a different area of study."	Different Interests (See 4.3.1)
"I struggled in one or more of my required CS classes."	CS Class Difficulty (See 4.3.2)
"I struggled in one or more of my required classes outside of CS (e.g., math, science)."	Non-CS Class Difficulty (See 4.3.3)
"I did not have enough time for CS."	Time Commitments (See 4.3.4)
"I disliked the CS program's required classes."	Different Interests (See 4.3.1)
"I had poor experiences with CS faculty."	Faculty (See 4.3.5)
"I felt isolated from my peers in CS."	Peer Isolation (See 4.3.6)
"I could save money by leaving CS."	Financial (See 4.3.7)
"I experienced incidents of prejudice in CS."	Prejudice (See 4.3.8)

4.2.1 New Field of Study. This section asks for the field of the respondent's new major, the factors that attracted them to their new major, and comparisons in areas such as "manageability of workload" and "faculty" between the new program and CS. Results from this section will allow CS departments to compare their program to other fields of study directly.

4.2.2 New Institution. Similarly to the New Major section, New Institution asks about the respondents' reasons for selecting their new school and their comparisons between their previous and new institutions. CS departments can use this section to determine whether leavers chose their new institution based on unchangeable factors (e.g., location/proximity to home) or potential areas of improvement (e.g., required classes).

4.2.3 Withdrawing. The topic of discontinuing studies in higher education is often associated with the stigma of terms like "dropping out." We therefore word this option for the future plans question as "To leave or take a break from higher education" to assure potential respondents that their decision is respected. This section asks for the respondent's reasons for withdrawing from a list of several options such as "Financial reasons," "Unexpected personal circumstances," and "I no longer need/want to go to school." We then inquire about the respondent's likelihood of returning to higher education to reveal students' individual persistence and any pitfalls that the department can potentially reduce, such as financial difficulty, as opposed to fully external factors, such as a family emergency.

4.3 Reasons for Leaving

The following survey sections are hidden by default and included based on the respondent's answer to Q6, "What are the 1-3 most important reasons you decided to leave your previous CS program?", as illustrated in Figure 1 and Table 2.

4.3.1 Different Interests. This section of the survey is the only section mapped to two of the possible answers in Q6: "I became more interested in a different area of study," and "I disliked the CS major's required courses." Since both relate to losing interest in CS or getting more interested about something else, both of those responses are branched to this section. Different Interests provides a list of computing-related topics, such as data science, game design, and cybersecurity, and asks the respondent to select any that they would have liked to learn about.

Purpose: Data from this section would be useful in determining what electives to offer each semester or to adjust required class curriculum to better fit students' interests.

4.3.2 CS Class Difficulty. The first page of this section asks the respondent to indicate in which classes they struggled most. Then, using the Qualtrics loop and merge feature, the survey will prompt the user for the course outcome and reasons they found the class difficult. If the respondent indicated more than two courses, the survey will randomly choose two of the selections about which to ask the followup questions. This is a further part of the effort to streamline the respondents' experiences with the survey to increase their likelihood of completion.

Purpose: Data from this section can be used to find potential ways to make the class requirements offered within the CS department less burdensome if it is found that many students have this experience.

4.3.3 Non-CS Class Difficulty. The Non-CS Class Difficulty section functions similarly to the CS Class Difficulty section described above (See 4.3.2). This answer option reflects additional CS degree requirements, such as math or lab sciences, not offered within the CS department.

Purpose: Some non-CS requirements, most notably calculus, have been reconsidered and adapted in recent years as studies have shown that they can negatively impact retention and persistence, especially for students of groups already underrepresented in computing [7, 20]. This survey section allows a CS department to see where particular pain points might be in their degree requirements.

4.3.4 Time Commitments. The section asks first if the student had any "major time commitments," such as taking care of a family member or being a student athlete. If so, they are asked about the frequency that their commitment(s) interfered with their coursework in CS. All respondents who receive this question are also asked to estimate how many hours per week they spend on homework outside of class.

Purpose: Data about these factors can assist departments in identifying scheduling issues, such as a need for more classes offered in the evenings, or for TAs and professors to be available for questions by appointment more broadly.

4.3.5 Faculty. If using this survey in a single-department context, respondents may feel concerned about the protection of their identity when discussing matters such as this one. This short section avoids open-ended questions to ensure the student does not feel obliged to share any information they would like to keep private. We ask the respondent how comfortable they felt discussing *course-related* concerns, as well as their comfort discussing *personal* concerns with faculty. This distinction is important, because many students never feel comfortable discussing personal issues with their professors, but they should be able to seek help for their classwork.

Purpose: Data from this section allows the department to see where professional development or training would be most beneficial for faculty. Respondents' answers can reveal whether the department should focus on classroom pedagogy, having sensitivity toward students, or some of each.

4.3.6 Peer Isolation. This section asks students about their number of friends both inside and outside CS, their attendance to any CS or STEM-related activities or affinity groups on campus, and whether their classes generally encouraged collaboration.

Purpose: Responses about activities can be used to determine whether additional activities should be added, or if they simply need better advertising. Classroom climate related to collaboration can easily set the tone for making new friends in CS, which is another adjustable factor from this data.

4.3.7 Financial. To honor the respondents' privacy, the only question in this section asks the respondents to select any factors that "increased the financial burden" of the CS program. The provided answer options list common issues, such as not having the time to work a job, or dealing with increasingly common differential tuition fees, where students may pay more tuition depending on their field of study [26].

Purpose: This section allows the department to see if and how finances impact CS leavers. Based on these responses, the department might consider offering more undergraduate jobs, creating need-based scholarship opportunities, or coordinating paid internships with local businesses.

4.3.8 Prejudice & Discrimination. At the beginning of this section, we define "personal identity" to refer to "*an individual's characteristics, including but not limited to race, ethnicity, gender identity, sexual orientation, age, religion, disabilities, and citizenship.*" We find it necessary to affirm that any incidents of prejudice, discrimination, or micro-aggressions are real and should be taken seriously. Each question in this section is essentially asked twice: first, focusing specifically on what is perceived to be unintentional prejudicial behavior (e.g., making someone feel unwelcome), and second, about intentional discriminatory behavior (e.g., threatening someone). This distinction helps to validate the detrimental impacts of prejudice of any form, while still allowing a respondent to indicate the presence of intentionally harmful actions in the CS community.

Purpose: Respondents' answers about unintentional behavior may lead a department to consider adding bias interruption training for their faculty or students [3]. Responses indicating intentional prejudicial behavior may warrant deeper investigation. These situations can be challenging to navigate but must be addressed to ensure a safe and welcoming environment for all.

4.4 Additional Comments & Demographics

After completing the branching path of the survey, all respondents receive an open-ended question asking for any additional comments. This serves as a mechanism for which respondents can make any notes that they did not get to share through the existing survey structure or put particular emphasis or elaborate on topics of their choosing.

The conclusion of the survey presents the respondent with demographic questions, reiterating that the questions are optional but will help to create a more equitable CS experience for all. The demographic information collected consists of gender, race and ethnicity, current class year, and the amount of prior experience in computing the student had before college. This information can help identify

any concerning trends in the barriers for underrepresented students in computing.

5 Illustration of the Survey's Use

One key feature of this survey is that it collects meaningful data to be analyzed as standalone responses or in aggregate. Here, we present examples of analyses at both individual and aggregate levels. This data was collected from our most recent public survey run, which received 45 complete responses. We received approval from our institutional review board to collect the data. Note that this section is not intended to show any generalizable results. It is only intended to demonstrate the survey's use and usefulness.

5.1 Collection of Third Pilot Data for Illustration of Use

For the purpose of this third pilot, we collected data from students who left computer science, who are now spread across a variety of programs, working in industry, or following some other path. This convenience sample was developed by posting the survey link to computing-related subreddits, as well as contacting various STEM-focused Greek life organizations to further spread the survey. We also include a message at the end of our survey to encourage snowball sampling, asking respondents to forward to other "leavers" they know, which may have significantly improved our sample size. Due to the relatively small sample size ($N=45$) for a survey with over 50 potential paths, any results of general interest are largely limited to the sections of the survey shown to all participants (namely the Introduction and Demographics sections). If adopted as a true exit survey for a specific department, individual responses will carry much more weight, as each one will provide information directly relevant to the local context. Demographic comparisons across the data allow departments to see whether specific issues are disproportionately impacting one group of students.

Below, we present the third pilot data, analyzing respondents' reasons for leaving by how many semesters they spend in the CS program before deciding to leave.

5.2 Analysis of an Individual Response

When a department first launches the survey and contacts all CS leavers from recent years, they can expect a relatively high volume of initial respondents. As the survey continues to be used across multiple terms, the potential respondent pool shrinks to the students who left most recently, and the responses will thus slow down. However, the branching structure of the survey allows for collecting specific, targeted feedback from each respondent.

To protect our participants' identities, we have constructed this sample survey response by taking each survey section from a different respondent, selected at random. All text-entry data has been stripped of personal details. We will refer to this example response as Respondent X. Full details about Respondent X's questions and answers can be found at <https://ncwit.org>. Based on the randomly selected demographic information, Respondent X is a first-year student who identifies as a Hispanic/Latine American man. We discuss Respondent X's answers to the survey and possible actions his previous CS department might explore if they receive similar results from others leaving the program.

5.2.1 Future Plans. Respondent X reported that his plans after leaving the CS program are to change programs at the same institution. He reports that he plans to change to a data or information science major. He cites his interest in the field, noting that his new major is similar to computer science with better courses. He finds that the faculty and his peers in the new program are of about the same quality as was in CS, and the manageability of his workload in data or information science is somewhat worse than CS. However, he notes that the required courses and overall learning experience are somewhat better than his experience in CS. According to Respondent X, he generally liked CS, but he found that the curriculum in data or information science better fits his interests.

5.2.2 Reason 1: *"I became more interested in a different area of study."* The Future Plans section provided information about Respondent X's new major, but this subsection will suggest what might have been more interesting for this student. He listed data science, systems and networks, computer architecture, and digital systems. We know from his demographic information that he was only in the CS program for two semesters before leaving, so he likely did not get the chance to take upper-division courses that covered these topics. However, the department may consider exposing early students to different topics through faculty talks or themed introductory course projects.

5.2.3 Reason 2: *"I struggled in one or more of my required courses outside of CS (e.g., math, science)."* Here, Respondent X reports that he failed the required calculus class for the computer science major. He cites "ineffective teaching or course structure," "difficulty seeking help," and that he "did not have the background knowledge that the instructor assumed the class had." Aside from doing away with the calculus requirement, the CS department has several options for helping their students in calculus. For example, the department may consider creating a help forum on a platform like Piazza or Slack for CS students taking calculus. Respondent X also mentioned struggling with assumed prerequisite material. The CS department may consider allowing a pre-calculus course to count toward their degree requirements. Alternatively, they could consider developing their own one-credit course to be taken prior to or concurrent with calculus.

5.2.4 Reason 3: *"I had poor experiences with CS faculty."* In this section of the survey, Respondent X reports that he felt very uncomfortable approaching CS faculty members about course-related concerns and very unsatisfied with the advising he received. However, he was only somewhat uncomfortable approaching CS faculty with personal concerns. This may imply that the faculty with whom the student worked were understanding about personal matters but needed more opportunities to work individually with students on classwork.

5.3 Comparisons Across Demographics

Variations between demographics in the survey data can help CS departments identify groups that would especially benefit from particular retention strategies. The survey collects demographic information about gender, race/ethnicity, prior programming experience, and duration of enrollment in CS, and our provided code will allow departments to use any of these categories to perform

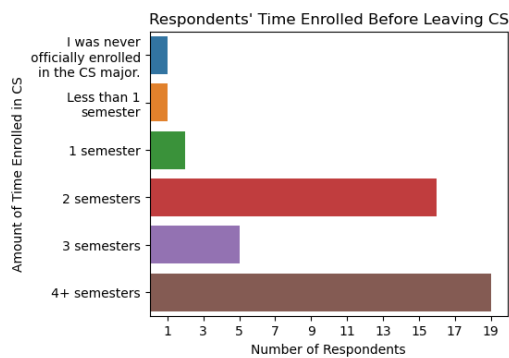


Figure 3: Respondents' Time Enrolled in the CS Major

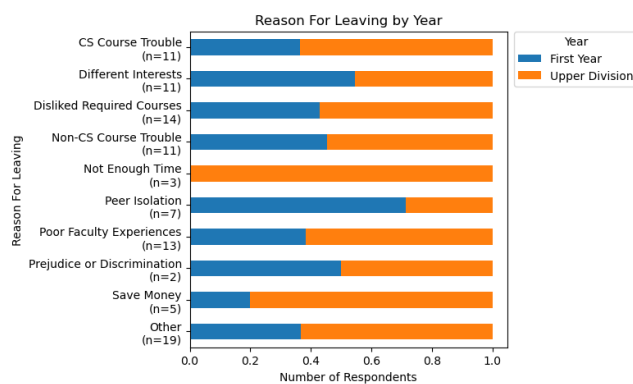


Figure 4: Proportion of Students From Each Enrollment Duration Category Who Reported Each Reason for Leaving

similar analyses. Our example analysis will use the length of time that respondents were enrolled in CS, as measured by number of terms. For our analysis, we categorized respondents into two groups: Enrolled for two semesters or fewer (which we will call "First-Year CS Students") and three or more semesters (which we will call "Upper-Division CS Students"). Figure 3 shows a roughly even split of responses across these two categories.

The pilot study data shows a visual difference between First-Year and Upper-Division respondents and their reasons for leaving (see Figure 4). Many of the reasons listed affected both groups about evenly, with the exceptions of "Not Enough Time," which had 3 out of 3 total reports submitted by Upper-Division CS Students, "Saving Money," which had been reported by Upper-Division CS Students 4 out of 5 times, and "Peer Isolation," which was reported a total of 7 times, with 5 of those reports being from First-Year CS Students.

If a CS department received these results, they may consider the following interventions. For example, all respondents who chose "Not Enough Time" as a reason for leaving were Upper-Division, indicating that workload becomes an issue following the first year of CS classwork. The department may consider building additional work into introductory courses to prepare students for the increase, or by offering support for study skills. Upper-Division students also reported leaving to "save money" disproportionately to our

First-Year respondents. This suggests that Upper-Division students may benefit from additional small scholarships, more student jobs within the department, or better connections to paid internships. In contrast, "peer isolation" was mainly reported by First-Year students, which might lead a department to teach introductory CS instructors collaborative learning approaches for their classrooms.

Our included analysis code for the survey also will provide CS departments with inferential statistics, but we encourage departments to look beyond the statistical test results. For example, here, we ran a Chi-Squared test to determine whether there was a statistically significant difference in each group's reasons for leaving. The current data resulted in a chi-square value of 9.904 with a p-value of 0.647 at 9 degrees of freedom, missing statistical significance by a wide margin. Yet, we can see differences across categories that may warrant action.

6 Conclusion

This CS "exit survey" is designed for use at local scales to find granular data and actionable opportunities to support computing retention at any university. This tool supports long-term data collection and analysis with little overhead required to manage it. We hope that by adopting this tool, any institution will be able to diagnose and address its retention issues.

Our survey is available as a free resource at <https://ncwit.org>. Campuses using Qualtrics can make a copy of the survey to fully customize to your department's specifications and individualized needs. If you do not have access to Qualtrics, the survey is also available as a PDF at <https://ncwit.org>. Alongside the survey itself, we have provided detailed instructions and template code for processing your results into visualizations.

Once institutions begin to adopt this survey, we hope to compile aggregate data from consenting institutions on a common platform. This will enable individual departments to compare their current data to averages reported by other institutions. This comparison could be especially useful for identifying factors of particular concern in your local context.

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