A Case Study of Environmental Factors Influencing Teaching Assistant Job Satisfaction

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ABSTRACT

Teaching assistants (TAs) play an integral role in teaching computer science undergraduates in North America. We report lessons in lab TA management, based on a case study which identified environmental factors affecting TAs' job satisfaction. These factors were identified through a series of semi-structured interviews about 23 lab sections taught at the University of British Columbia. We corroborated this with observational sampling of eight different TAs. Identified physical factors affecting job satisfaction include the layout and lighting of the lab rooms. Temporal factors include the intensity and length of the lab sessions. Having a positive social environment (in particular, support from team teaching and staff meetings) was also found to improve job satisfaction.

Categories and Subject Descriptors

K.3.2 [**Computers and Information Science Education**]: Pedagogy, education research

General Terms

Human factors

Keywords

Computer science education, teaching assistants, labs

1. INTRODUCTION AND MOTIVATION

Teaching assistants (TAs) play a vital role in teaching computer science (CS) undergraduates: at many institutions, students spend more time with the TAs than course instructors [7]. In the way we teach CS in large research institutions, we have a culture of high TA use, low student retention, and high failure rates in CS1 [5].

TAs have been found to influence retention [16], and students' performance in labs have been found to be a predictor of success on final exams in CS1 [4]. Within the TA-taught labs, correlations have been found between interaction with TAs and performance on final exams [18]. More interaction and more active observation[1] (as opposed to passive observation) were both found to improve their students' marks, and asocial behaviour of TAs[2] was linked to lower marks. Furthermore, it is known that TAs' favourite part of their job is interacting with their students [7]. In short, the more a TA interacts with their students, the happier they are at work, and the better their students do in class.

Yet, despite enjoying student interactions, TA quality remains an issue [15]. We take the position that the situation is more complex than some TAs just being "bad" – that there are also environmental factors preventing TAs from having quality interactions with their students.

1.1 Research Study

In this work, we seek to answer two research questions (RQs):

RQ1: What environmental factors affect TAs' reported job satisfaction?

RQ2: Knowing that interaction with students is the TAs' favourite part of their work, what environmental factors affect TAs' interactions with students?

Ever since lab-based instruction in CS took off in the 90s [8], the CS community has borrowed environmental approaches to teaching labs from other disciplines. For example, despite the lack of equipment necessitating it, we use workbench-style layouts for lab rooms, taking after physics and chemistry. Like those fields, we have borrowed the three-hour format for labs at our institution – yet our students can save and complete their labs at a later time. We think that we can do better by tailoring the lab environments in CS to the discipline itself, and by identifying and diffusing environmental factors impeding the work of CS TAs.

Although no existing work has examined physical environmental factors affecting teaching assistants' experience on the job, prior work on K-12 teachers has identified physical factors such as lighting, windows, acoustics, the height of the ceiling, the layout of the room, and the number of walls [1, 6]. The social environment has been found to affect TAs; in particular, studies of TAs have found that a lack of social support structures for TAs negatively affects their work [7, 15]. We speculate that, since TAs are less trained than K-12 teachers and generally less experienced, they would be more sensitive to environmental distractions.

[1]Active observation is defined to be focused observation on what a student is doing, lasting for more than five seconds.
[2]E.g. checking their email, grading assignments, being outside the room.

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2. METHODS

Our study had two portions: one qualitative, and one quantitative. First, we performed semi-structured interviews asking TAs about their experiences teaching labs. In the interviews we made note of what environmental factors the TAs noted as affecting their experience as a TA, and what effect the factor had (positive/negative). Our qualitative approach allowed us to build a theory of what factors mattered to the TAs at our institution; exploratory theory-building is a strength of qualitative approaches. Quantitative approaches, in contrast, are useful for validating and testing theories. The second portion, which was quantitative, allowed us to test the readily quantifiable portions of our theory.

Both portions of the study were part of a larger study of TA experience at our institution; the data used in this paper are a subset of the data collected in the whole study.

2.1 Interviews

We began with semi-structured interviews: we had nine participants, who were interviewed for an hour each. Our unit of analysis is the lab section; each participant was interviewed about *each* lab section they had taught; a total of 23 sections were described by our TAs.

The interviews began with a *grand-tour question*[3], an open ended question which allows the interviewee to set the direction of the interview [19]. We did not directly ask TAs which environmental factors affected their enjoyment of teaching a given section – only what their experience was teaching each different lab section they had ever taught, and how the sections compared to each other[4]. This allowed us to see which factors would emerge without direct probing, or biasing the interview towards the factors that we expected the participants to note. We analyzed the interview data using affinity diagrams [13] to categorize our data and identify patterns in our results.

We recruited interview participants at the course staff meetings of first and second-year courses and at a general event for TAs of the department. TAs with whom the author had worked were deliberately excluded from the study. We interviewed nine TAs, after determining from Guest et al. [11] that at least six participants would be necessary for the study given its exploratory nature and our goal of theory-building. As this was a qualitative, theory-building exercise, we were unconcerned with drawing a random sampling – we wished to generalize from our findings to theory (analytical generalization) as opposed to generalizing from a sample to a population (statistical generalization).

2.2 Observational Sampling

There is a long history of observational methods in the behavioural sciences; *observational sampling* refers to a family of quantitative approaches therein. In observational sampling, the observed behaviours are categorized and tabulated; the time or frequency of particular categories is analyzed quantitatively. This stands in contrast to qualitative observational styles, where the observer describes the situation at hand, trying to explain or depict the scenario. Like all qualitative methods, that approach is excellent for exploring and generating hypotheses; for validating or testing, however, quantitative approaches are more appropriate.

While the CS education community has used qualitative observational methods in the past, observational sampling remains uncommon (but not unused, e.g. [10]). An observational study was most suited to our larger research study on TA experience – to complement the interviews – and by using this approach we could do quantitative analysis of duration/percentage of behaviours. This approach has been used in the physics education community, such as in Paul et al's work with physics TAs [18].

A common element of all observational sampling methods is the use of an *ethogram*; this is a well-defined catalogue of behaviours. The categories of behaviours are intended to be mutually exclusive and as objective as possible. For example, "active observation" in this study is defined as "the TA is seen staring at a particular student or a student's computer monitor for a duration exceeding five seconds". We cannot know if the TA was actually thinking about the student's work or was just mindlessly gazing in that direction; but this allows for clarity, consisitency and repeatability in our data.

The ethogram we used for observing TAs had five categories: making class announcements, observing students or partner, interacting with students, interacting with partner, and "non-interaction" (Table 1). Each category has several subcategories; the latter category contains subcategories such as working on a computer and being out of the room. This ethogram was adapted from Paul et al's work in observing physics TAs [18]; Paul only looked at student-TA interactions so for this study we added an additional category for logging TA-TA interactions.

A second element in observational sampling is the difference between states and events; in state-based sampling, as we have done in the paper, we are concerned with how long an observed individual remains in a given state. This allows us to investigate duration. In contrast, events are instantaneous. The choice of whether to sample events or states has an effect on the choice of observational method and should be based on the type of research question.

Altmann's 1974 paper [2] on observational sampling is a definitive guide to the different approaches; in the paper she discusses six, appropriate to different research questions and whether one is observing individuals, pairs, or groups. The techniques are applicable to the study of both human and nonhuman animal behaviour, and have a long history of use in both areas.

In our study, we used a technique known in Altmann's paper as *focal animal sampling*; it is also known as focal individual sampling, or when studying a small group, focal group sampling. It refers to sampling all occurrences of specified (inter)actions of an individual or small group [2]. In focal animal sampling, non-social behaviours are straightforward to document; for social behaviours we also need to define receivers and actors. This method is suitable when there is only one or two individuals that we need to observe. In state-based focal sampling, we note the time at which each new state begins; cumulative time in given states can then be computed.

[3]Typically, "What has your experience been like as a TA?" Alternate wordings were used.

[4]We would first ask the participants to list all the courses they had TAed, and their duties for each. As we went through the list, we would ask questions like "how did you like teaching your Wednesday section?" or "how was the morning section different from the evening one? Which did you like teaching more?"

Category	(A) Addressing the class	(O) Observing student(s) or partner	(I) Interacting with students	(T) Interacting with partner	(N) Non-interacting
Example subcategories (not full list)	**A:** announcement **L:** lecturing the class on a concept **C:** clarifying text in the lab **W:** writing on the whiteboard	**PF:** passive obs. from the front of class **PW:** passive obs. while walking **A:** active obs. (>5s spent on one student) **T:** obs. partner	**L:** listening to the student **F:** questioning the student **S:** socializing with the student **A:** answering student's question	**G:** discussing strategy **U:** updating their partner **E:** explaining the lab to their partner **S:** socializing	**R:** out of room **G:** grading **C:** using computer **W:** wandering around not observing students

Table 1: Example ethogram codes; the code AW, for example, denotes a TA is writing on the whiteboard.

A trade-off to consider with any observational methods is that between observer fatigue and accumulating a representative distribution of samples. It is standard to take breaks at a consistent periodicity (e.g. sample for twenty minutes, then break for five, repeat) to ensure consistency in sampling. Every five minutes we also switched between which of the two TAs we were focusing on, as logging all behaviours of both TAs at once would have been a strain on the observer. Eight hours of observations were done of four pairs of participating TAs.

3. CONTEXT

The study took place at the University of British Columbia, a large, research-intensive university. The CS Department is home to 55 faculty members, 200 graduate students, and 1300 undergraduate students. In the 2010-11 academic year, the Department filled 153 full-time graduate student TAships and 56 undergraduate TAships.

The study considered only lab TAs. Laboratory sections in undergraduate courses are usually taught by pairs of TAs, borrowing a common practice from labs in the natural sciences and engineering. Sections typically contain 20-30 students, and meet weekly for two or three hours (typically ten times in a twelve week term). The lab rooms are all of similar size and have generally similar acoustics, although the layout varies.

Labs are more common in first and second-year courses. It is common for TAs to meet in weekly staff meetings. Weekly "lab TA meetings" are also held in the two largest first-year courses, in which lab TAs work through the labs in advance.

4. FINDINGS

4.1 The physical environment

4.1.1 *Layout of the room*

Participants reported having better, and more, student interactions in lab rooms with open layouts than in rooms with traditional "classroom" layouts. We illustrate the difference between these layouts in Figure 1.

Participants who had the experience of teaching in both types of rooms reported preferring the open layouts. As one participant noted, *"the lab layout in [a traditional room] is not as friendly to walking around as [an open room]. When I'd teach [traditional room], I'd walk around a bit, but it is harder. I'd wind up sitting at the front more."*

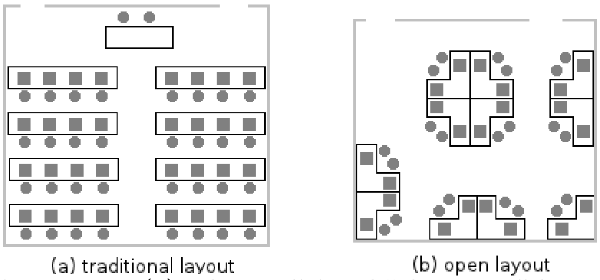

Figure 1: In (a): the traditional "classroom" layout; in (b), an example of an open layout.

We found that TAs who worked in traditional rooms would sit down during lulls in student questions. We noted this in both interviews and observations. While most TAs would periodically take a tour of the room, they tended to make themselves comfortable while waiting for questions – *"[My partner and I] would let the students go crazy with the labs and we would sit at the front. [We'd] try out things on our computers."*

For the TAs in the open rooms, they reported – and were observed – spending those lulls walking around and looking at what the students were doing. As one participant describes it, *"Generally somebody always has their hand up, otherwise it is 'Brownian motion' – walking around slowly, when passing a student I'll a look at them. I'll be looking for students that don't ask questions but need help. If I have extra time I try to be as invasive as possible."*

During these lulls in the open rooms, TAs were more likely to socialize with their students; with the increased opportunity to access students in the room, *"I get to interact with the same group of students, so we develop a friendship sort of thing. It's fun knowing they can turn to me when they need help in lab."*

We observed that TAs in the open rooms spent almost twice as much time interacting with students than the TAs in the traditional rooms, as we saw in our observations (76% of their time vs. 40%). Furthermore, the TAs in the traditional rooms spent much more time doing "non-interacting" activities like texting on their phones (18% of their time vs. 7%). Also, TAs in the traditional rooms did spend much more time talking to their partners than the TAs in the open-rooms (26% vs. 3%). The open-room TAs spent less time overall observing their students (9% vs. 14%) but more of that observation was active as opposed to passively looking at their students from the front of the room.

4.1.2 Lighting

Participants noted better teaching conditions in rooms with more windows, which were better lit. As one participant noted, *"I like [well-lit room], it feels brighter. [The lab I teach in there] feels fun, friendly, not only amongst the TAs but amongst everyone."* The well-lit rooms were described much more positively, with TAs reporting having better moods in those rooms. It should be noted that the layout of the room is not related to the lighting: both types of layouts have a range of lighting.

We noticed that TAs in the rooms without windows were more likely to describe little interaction in their labs when interviewed. We noticed that they described their students as asking fewer questions, and that they would approach their students less often. In our observations of TAs, we found that TAs in the windowless-rooms spent noticeably less time interacting with students, making announcements to the class, and observing their students. Furthermore, the TAs in the windowless rooms also spent more time doing "non-interacting" activities, particularly surfing the web and using their phones.

4.2 The temporal environment

4.2.1 The intensity of the session

Participants preferred teaching labs where there was ample time for their students to complete the lab in the allotted time period, where the intensity was neither too high, nor too low. We use 'intensity' to refer to how often there are gaps, or "lulls" between student questions; a high-intensity lab would have no lulls, while a low intensity lab may involve long stretches of time without any student questions.

TAs in high-intensity labs were less likely to have time to sit down and talk to their students in depth, or have a chance to talk to their partners about their students. These TAs reported lower job satisfaction due to feeling "rushed", not having enough quality time with the students, and feeling bad when their students did not complete the labs on time. Indeed, for these TAs, not having students finish on time was a source of stress. Only the first-year introductory programming course had such high-intensity labs (which were three hours in length); for one participant, the fact that this was the students' first experience with CS added to the stress of the high-intensity labs.

Two courses were reported to have very low-intensity labs, one with three-hour labs and one with two-hour labs. A participant from the latter course reported *"I would have my laptop out and not be disturbed for an hour, hour and a half"* when teaching those labs, which had optional attendance. For the participants in these two courses, the low intensity resulted in boredom for the TAs, and a desire for students to ask them more questions.

The medium-intensity labs were described most positively. These were labs where TAs had regular questions to keep them engaged, but had enough "breathing time" to sit down with students and talk in detail, and restroom breaks.

In our observations, we only observed high-intensity and medium-intensity labs. The difference we saw here was in the frequency at which the TAs switched from student to student: the TAs in medium-intensity labs spent more focused time with their students. The TAs in high-intensity labs did spend more of their time interacting with students, but spent an average of only 7 seconds per student question, while TAs in medium-intensity labs spent an average of 20 seconds per student question.

4.2.2 The length of the session

Participants who taught three-hour lab sessions described their work as more "tiring" than participants who taught two-hour lab sessions. This was true regardless of the intensity of the lab. Three of our nine participants had experienced burnout; they were all on three-hour labs.

Of the nine interview participants, two were no longer teaching labs, both of whom had been on three-hour labs. One tired of the labs due to the stress: *"this term I'm on office hours instead of labs. It's a lot less stressful. [The three hours labs were] very draining... I'm not sure if I want to teach those labs again."* The other TA, from a different class, had much less intensive labs, instead tiring of the three-hour labs since *"there was a lot of time where we were idle... it takes a lot of patience... I needed a break from attending them. The labs were tiring since they were three hours, and most students took half that time."*.

The other interview participants who taught three-hour labs also described them as "tiring" or "draining" – regardless of the described intensity of the activities. One of those participants had spent a term taking a break from labs in favour of marking assignments and office hours, but did resume teaching labs. Another participant on a course with three-hour labs reported that the workload was unsustainable for him, noting difficulty balancing work on his thesis.

The participants who taught two-hour labs, however, did not report finding them "tiring" or "draining", and were all enthused at the prospect of teaching more labs. One participant who had experience teaching both two-hour and three-hour labs noted the two-hour labs as being easier to teach.

In three-hour labs, we saw differences in how TAs behaved between the second hour and the third hour, but no differences between the first and second hours. TAs spent less time giving announcements in the last hour, and more time observing their students. However, how much the TAs interacted with their students did not change over the course of three hours.

4.3 The social environment

All the TAs involved had at some point taught in pairs, which was universally reported as a positive experience for them. Having a partner in the lab contributed to a sense of social support, improving job satisfaction. Friendly relations with one's partner was reported as a motivating factor when teaching, as well as for preparing for the labs, as *"you don't want to let them down or make them do all the work."*

The partner was also there to help out with student questions: *"if there's minor details I don't know I can ask him [my partner]. And if there's something I can't explain, then maybe [he] knows how to do it.... And it's funner when [he]'s around."* The partner would also give the TAs a sense of security – *"I like teamwork. Two's a good number, two is perfect. It's really easy to come to agreement on things. And it's nice to have somebody covering your back."* Indeed, when probed as to whether TAs would prefer to teach solo or in groups, all nine participants reported preferring teaching in pairs, citing the balance of social support with the ease of coordination.

Another source of social support that boosted job satisfaction was staff meetings. TAs felt more valued and had higher job satisfaction when they had staff meetings where the instructor involved the TAs in the discussion, and solicited their feedback. The social support when teaching also contributes to the TAs' growth as teachers; TAs reported finding it highly useful when instructors gave them feedback and encouragement on their job performance, and advice about their work.

The sense of collaboration in the staff meetings that one participant felt was reported as his *"favourite part of being a TA"*. Staff meetings would also provide TAs a chance to talk to their partners – *"[in addition to in lab] we'd also talk in the TA meetings. There's a really friendly atmosphere between the TAs."* Of the nine interview participants, only one participant had a negative experience with staff meetings, where the course instructor was frequently absent, did not listen to TA feedback on the labs, and seemed to have been *"mostly making up the course as he goes along"*. Like the TAs in Bomotti's study [7], this TA reported feeling insufficiently supported and appreciated.

5. CORROBORATING EVIDENCE

Layout. In K-12 education research of classroom layouts, it has been found that open layouts are positively related to teacher satisfaction with the classroom, as was greater ceiling height [1]. Additionally, experience reports in lab-based instruction in physics have favoured open layouts, which are associated with encouraging collaborative learning [12, 3].

Lighting. There is a large body of evidence in the psychology literature that lighting has an effect on mood and cognition [14, 20]. It is hence unsurprising that lighting was found to have an effect on TAs' working environment.

Intensity. Reducing the workload for labs so that students complete them on time has been found in a longitudinal case study to have improved student perceptions of labs and TA job satisfaction [17].

Length. There are a number of possibilities for why length – independent of intensity – would affect TAs' performance. Lower blood sugar levels will result in less energetic teaching. Decision fatigue would also play a role, as teaching is a profession where decision-making is constant [9]. Finally, maintaining an authoritative position amongst the students is a high-effort social activity – something that TAs, as younger teachers, have had less chance to develop stamina for.

Social support. Muzaka's study of TAs [15] – who worked solo – found that those TAs suffered from a lack of social support. Muzaka noted the lack of support structures available to TAs as a negative influence on their work. Furthermore, in Bomotti's study [7], TAs noted feelings of being insufficiently supported or appreciated, and that they felt "overworked, underpaid, and unappreciated." Finally, Bomotti notes that "TAs who plan to pursue college teaching as a career regard high-quality supervision as the single most positive influence on their decision" [7].

6. THREATS TO VALIDITY

With a mixed-methods approach, we can be more certain of our results as they are corroborated by multiple methods. Each method has its own advantages and disadvantages, but together they can build a clearer picture of what we are trying to study.

As eight out of nine interviewed TAs reported a positive social environment for teaching, we have little to compare socially supported TAs to socially unsupported ones. Also, the choice of student interaction as a proxy for job satisfaction is, by nature, an imperfect measure; hence we only use this to verify the themes which emerged from our interviews. Another weakness in our use of observational sampling is that we did not observe a low-intensity lab, presenting a threat to validity in subsubsection 4.2.1.

We do not claim to have listed every environmental factor affecting every TA, only the ones that were found to matter in our specific context. The time of day of a lab – affecting student and TA metabolism – and the day of week – affecting how "smoothly" the lab proceeds – were each mentioned by only one interviewed TA, and were hence omitted. Room acoustics have been found in other studies [6] to be significant, but was not identified by our participants, likely due to the similar acoustics between rooms.

In subsubsection 4.2.1 we factor whether students completed their work on time into the intensity of the lab; these may be seen as distinct. However, we were unable to examine them individually: the only course where students were unable to complete the labs was one with high-intensity labs.

Similarly, in subsubsection 4.1.1 we were unable to distinguish two factors involved in layout: the physical effect of access to students that the open layout affords and the traditional layout lacks, versus the psychocultural effect of students all facing the front in the traditional layout which is not present in the open layout. While one of the traditional rooms did lack a table at the front for the TAs to sit at, we do not have enough evidence in this study to fully separate these two factors.

As we expected from our study design, we reached saturation in our interviews, with nine participants interviewed. Saturation refers to a state in which no new concepts, or codes, emerge, as more interviews are done. However, bias may be added through the process of interviewing the TAs – as we asked them questions we had generated – and through coding. As the author is a TA herself, it is possible that the analysis was skewed towards reflecting the author's own experiences.

However, by being a peer to the participants, we feel we had their trust; we feel TAs were as a result more open and honest during interviews, and behaved normally when under observation. We speculate that had a faculty member run the study, we would not have heard anecdotes about being uninterrupted for "an hour, an hour and a half", nor would we have observed some TAs spend nearly a tenth of the time playing with their phones.

7. SUGGESTIONS FOR INSTRUCTORS

We have identified five environmental factors affecting TAs' job satisfaction in our case study: the layout of the lab room, the lighting of the room, the intensity of student questions, how much time is allotted to a given lab session, and the social support given to the TA.

Based on the model that we have constructed from our findings, we make four suggestions to course instructors on how to manage their labs:

1. Avoid scheduling three-hour lab sections, and ensure that the students can comfortably complete the labs in the allotted time. Three-hour labs tire out your TAs.
2. When writing labs, consider the intensity for the TAs. Further, TAs are demotivated when students do not complete labs on time.
3. Provide a positive social environment for your TAs. Actively solicit their feedback during staff meetings, and collaborate with them in making changes to curriculum and course policies. Furthermore, our participants reported working in pairs to be a source of social support for them.
4. Schedule your labs in rooms with the best physical environment you can – with a layout that supports TAs having easy access to their students, and good lighting. As TAs reported feeling pressure to give students in introductory courses (CS0 and CS1) a positive impression of the field, we suggest prioritizing those courses when assigning lab rooms.

Additionally, we suggest to those on space committees, or facing renovation, to design lab rooms with open layouts, ample windows, and proper lighting.

Improving the job satisfaction of TAs promotes a healthier teaching environment, and in turn, a healthier learning environment for the students. It also promotes retention of TAs to the courses they are assigned to – resulting in a more experienced teaching staff in subsequent terms.

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