Reflective Teaching Practice in Computer Science? A Tale of Two Instructors

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We lack a strong understanding of how those who teach computer science solicit and use feedback to improve both their teaching practice and course designs. This study explores how computer science instructors collect feedback, their attitudes towards different feedback sources, and how they use this feedback to adjust ongoing courses or redesign their course for future cohorts. Data indicate that instructors are using a variety of feedback sources to adjust their teaching practice or course designs. These instructors focused on the feedback they received through anonymous feedback tools or interpersonal communication and student performance on required course activities. Their use of this feedback revealed different strategies for supporting students and differing abilities to adjust their beliefs about students.

Keywords: Feedback, Computer Science Education, Higher Education, Instructor Practices

Student feedback is an important trigger for changes in teaching practice in higher education (Penny, 2003). Instructors are constantly evaluating their performance in a course by gathering, interpreting, and acting on direct or indirect feedback from students. Unfortunately, student feedback in computer science courses tends to be sparse on contextual details, non-representative, or arrives too late to facilitate timely change, with the collection of feedback being a sensitive political issue (Penny, 2003).

Issues arise from the tension between summative feedback for evaluating instructors and formative feedback to support their continual improvement and reflective teaching practices. Student evaluations of teaching (SET) are the most common means of obtaining student feedback in higher education and focus on experiential aspects of learning (Stark & Freishtat, 2014). Using these evaluations for summative purposes presents various issues. One being that only future cohorts benefit since the current cohort cannot benefit from rating instructor performance after the fact (Arthur, 2009). SETs have also been criticized (Arthur, 2009) for attempting to reductively measure the performance of educators, rather than yielding timely and actionable feedback that instructors can use to improve. Instructors also feel students may not be qualified to judge their performance, and institutional pressure to perform is at odds with instructors' professional principles. Despite these shortcomings, SETs have two main advantages that enable comparison across cohorts: they document student experiences and give students an opportunity to provide feedback (Richardson, 2005).

Traditionally, student feedback has been defined as a learner-instructor interaction in which the student conveys information directly or indirectly about their experience with a course to the instructor (Barker & Gruning, 2014). Yet, many aspects of student learning behavior fall outside of that definition, and such information is difficult to access by instructors since it occurs without instructor involvement. As online and blended courses increase in popularity, access to data from learner-learner and learner-material interactions is becoming available alongside learner-instructor interactions. This access can enable course monitoring that informs teaching decisions. For example, Phirangee (2016) identified seven learner-learner interactions that lead to feelings of isolation, alienation, and disconnection in online courses, and Phirangee et al. (2016) automated the identification of behavioral patterns that are tied to these student feelings. Being able to see and understand these negative learner-learner interactions provides valuable feedback to instructors which allows them to foster richer online discussions.

Although arguments have been made for harnessing student feedback, it is not clear how instructors use student feedback to modify their courses to better meet student needs. Instructors need to understand how students are engaging with the course, how they respond to teaching practices and materials, and how these elements can be improved for current or future cohorts. According to Huxham and colleagues (2008), these types of student feedback enable professional development through reflective teaching practices. The need for this feedback is particularly pronounced in computer science, where there are concerns about student retention and diversity (Barker and Gruning, 2014).

The current research focuses on the various ways computer science instructors review, understand, and use student feedback to improve their teaching and courses. Specifically, the following research question is explored:

- How do computer science instructors use student feedback to better inform their teaching practice and course(s)?

Theoretical Framework

The scholarship of teaching and learning (SoTL) is an approach that "encompasses a broad set of practices that engage teachers in looking closely and critically at student learning in order to improve their own courses…" (Hutchings, Huber, and Ciccone, 2011, p.xix). Conceptually,

this approach merges scholarly inquiry with teaching activities (Hutchings et al., 2011), to improve student learning and the education being provided.

In the context of student feedback, instructors are using that feedback to look more constructively at their teaching to improve their practice and course(s), and to better meet student learning needs. More specifically, reviewing and dissecting student feedback is a practice that allows teachers to become more reflective and engaged in how their students experience learning and the teaching activities that work or do not work within the context of a specific course. Exploring student feedback closely and critically is needed because investigating questions relating to student learning, including the conditions in which it occurs, what it looks like, and the ways it can be deepened will both improve the learning environment and advance teachers' practice (Hutchings and Shulman, 1999). Not doing so would be a disservice to both teaching and learning.

Methods

We conducted a term-long (16 week) study to see how computer science instructors adjust their teaching practice and respond to implicit and explicit feedback. This study employed maximum variation purposive sampling (Devers & Frankel, 2000) so that we could contrast potential extremes in instructor experiences and attitudes. As such, an experienced and a new instructor were recruited, with one teaching inside his area of expertise and the other teaching outside of her area of expertise. These instructors were also teaching courses that required vastly different domain skills for students to succeed. Data were collected using various methods at multiple time-points to see the full range of instructor experiences.

Participants

Andrea[1] is a teaching-stream associate professor with a BSc in computer science and an MSc in a sub-area of computer science that requires high levels of technical proficiency and programming ability. She has over 15 years of teaching experience and has won several teaching awards. She also conducts research in computer science education. During this study, Andrea was teaching a Web Development course which is outside her area of expertise.

Chris is a teaching-stream assistant professor who has completed bachelor's degrees in mathematics and education. He has also completed an MSc in a math-intensive sub-area of computer science. This was his second year as a professor and he was teaching a course (Computational Theory and Data Structures) that directly related to his area of expertise.

Instructional Context

Like our participants, the courses they taught were different. The first, Computational Theory and Data Structures, is an abstract math-based course that students generally consider hard. Coursework is usually performed on paper and the content is conceptually difficult: it involves working with abstract concepts and proving aspects of computation. In this course, knowledge of a task tends to generalize well to other tasks of the same type and there is a small set of task types, so students need to develop schemata and learn to recognize and apply these patterns.

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[1] Participants have been assigned pseudonyms

The second course, Web Development, is not conceptually difficult nor do students perceive it as being difficult. However, it requires a lot of detailed implementation work that does not generalize well from one technology to the other beyond the highest level of abstraction (e.g., they all display information in a browser and have a computer that serves content). Browser incompatibilities; the distribution of tasks across machines (server/client); the variety of technologies; and building websites that force a protocol, which is inherently stateless, to have state make the tasks in this course difficult.

Both courses were offered during the regular fall term, which runs from early September to early December. Feedback sources included the use of a system that allowed students to submit anonymous feedback, interaction with students or the artefacts they created, feedback from other instructional staff, and previous SETs.

Data Collection
Two sources of data were collected: diary entries about instructors' experiences and interviews.

Instructors were asked to keep a diary of the feedback that they had received or changes that they were going to make to their course. Email reminders were sent at least once a week, so instructors did not forget to create diary entries for relevant events. The diary template asked instructors about the events that prompted them to reflect on their teaching practice, the source and nature of any feedback they had received, their emotional response to the feedback or event, and their actual or planned responses.

Chris submitted 7 short diary entries describing feedback events. Andrea submitted 7 detailed diary entries.

Both instructors participated in semi-structured interviews with Author 3. These interviews focused on their experience teaching computer science, their experience teaching the course, the feedback they received and how they solicited that feedback, their assessment of student knowledge, how they use feedback, how they adjusted course materials, and their use of the online discussion boards. In addition to this information, interviews were used to clarify and expand upon instructors' diary entries.

Andrea participated in three interviews. There was a recording problem so data from the first interview were lost. The second one took place in October and lasted 30 minutes. The third occurred after the term had ended in December. It lasted 46 minutes.

Chris was interviewed three times. The first interview was at the start of the term. It lasted 46 minutes. The remaining interviews were shorter. The second was held one month later and lasted 24 minutes. The third, which was 34 minutes long, was held about two weeks before the end of term.

Data Analysis
The interviews were recorded and analyzed by two coders (Author 1 and Author 2). Coders listened to the interviews and identified emergent themes (Charmaz, 2010). These coders then compared the themes that they had identified. The same process was applied to the diary data.

Findings

Five themes about how instructors harnessed student feedback to improve their teaching and courses emerged from the interviews. The themes are summarized here. Additional details and mappings between themes and quotes can be seen in Table 1.

- **Informal and Formal Feedback.** As a result of soliciting student feedback, formally through evaluation systems and informally through discussions, instructors were able to adjust their course(s), specifically in how they taught the content or assessed student knowledge. For instructors, encouraging their students to provide this feedback was one way to show students that their feelings and views are both heard and respected.

- **Building Student Trust.** According to both instructors, building student trust involves making students feel comfortable, secure, and emotionally supported. For example, Andrea shared the importance of proactively talking to and checking in on students, especially the "quiet ones". While Chris was more reactive than Andrea, their addressing of students' emotional needs allowed instructors to get a deeper view of students' experiences in the course.

- **Instructors Struggle to Keep Up.** Both instructors expressed they sometimes struggled to familiarize themselves with the material quickly enough to teach well (i.e., ensuring exams have an appropriate length or eliminating errors in lab descriptions). For Chris, student feedback made this more apparent. In contrast, student feedback from Andrea's course suggested that they had yet to notice she was having trouble keeping up.

- **Understanding Students.** Both instructors emphasized a need and want to understand students' experiences in their courses. However, it was clear that Andrea's understanding was flexible and based on interacting with her current students, whereas Chris's understanding was based predominantly on his prior beliefs (e.g., computer science students should be better at his course than engineering students) with little evidence of changes in his beliefs over the term even when he discussed circumstances that contradicted those beliefs.

- **Monitoring Discussion Forums.** Overall, discussion forums were viewed as a potentially helpful tool. However, instructors expressed concerns about how to properly monitor the forums to effectively meet student needs and complement their course. For example, Andrea received help from TAs which challenged biases towards discussion forums, whereas Chris did not receive help and continued to struggle with the forum and his accompanying biases against it.

Table 1:
Exemplar quotes by instructor and theme

Andrea	Chris
Theme: *Building Student Trust*	
"Students were expressing anxiety about the assignment that was due yesterday. The key piece of anxiety is that they are uncertain how their work will be evaluated in comparison to other students. I realized that I'm asking the students to trust me to 'do right by	"Relief mostly directed at the bell-curving …. even with this bell curve they didn't do that great" "It was mostly about calming students down and helping them out emotionally … I didn't want it to

Andrea	Chris

them' in a way that they are not really used to. So far, they have to take me at my word that we will appropriately grade work done by novices that meet the assignment specifications, and not be influenced by more experienced students who are capable of doing much more."

"I'm spending a lot of time reassuring students"

"I want to keep them [students] on my side, not for me, but for their own learning"

"Because I worked so hard to gain students' trust … they're willing to allow me to make some of those mistakes without it being a death knell … I'm able to bring a perspective to the topic even though … I keep saying I've been learning this as we go along … that helped build up the confidence of the students in what they were learning from me had shape and meaning and relevance."

"Making them feel good about what they're learning and that they're learning. That they can learn."

kind of poison the atmosphere for the rest of the term"

"Making sure that I appear as approachable and nice as possible during office hours because it is something that I've gotten some feedback on … some people have said I come off as standoffish or condescending during office hours."

Theme: Informal and Formal Feedback

"The instructions were misleading. Some of the TAs discovered the inconsistencies and help students fix it immediately in the lab. Some students either didn't go to the lab or didn't talk to these TAs and remained confused. The upside was that they came to me during my office hours to ask about the lab. I learned a lot more about what they were finding challenging in an hour or so of talking with students than I have during lectures or when answering questions on Piazza"

"This poll came up on Piazza, 'but I'd really like an extension' … I felt that because we'd followed the rules and taken a vote [in class] that I couldn't could not now extend it even if I wanted to"

"There are students … who like to talk… although I do try to poke at students who are quieter… but anybody who's willing to talk to me about their experience… I'll take any opportunity to ask how things are going"

"I have for some years tried to solicit feedback regularly and ad-hoc"

"I probably shouldn't say this, but I tend not to put much stock in the course evaluations [SETs]… response rate is so low that it's hard to know what to make out of it, out of the comments, and partly because I find them really contradictory"

"I look for constructive, constructive comments and criticism to see if there's anything I can improve on. I tend to get a lot more from a back and forth conversation"

"Got some anonymous feedback after - criticizing the length [of the midterm]"

"There was also a poll on Piazza that students started that asked about, I think, the length and the difficulty [of the midterm]"

"Quality of questions they're asking during lectures ... whether they're responding when I ask questions to them ... their performance on assignments and tests, and then my reports from my TAs about, kind of, how they do during the tutorials"

"The most common source of feedback that I get is two kinds: one kind of in person during my office hours…. sometimes I'll actually ask them how they're feeling about the course overall… and the other mechanism is through the anonymous feedback that I set up on the course website"

"I don't think it [feedback] translates that well [to other students]. Obviously, there's a big selection bias"

"Even at the end with the course evaluations… generally I don't even take ... those to have that much weight because my response rate is usually below 50%"

"Official course evaluations … My usual interaction with it is I'll read them … so it will be like a random day in the middle of next term [when we get the SETs]. My mind is somewhere completely else … somebody around me will start to talk about course evaluations, and I'll think I guess course evaluations are out … The numbers are all roughly about the same … [comments]

Andrea	Chris
	I accept as a wash. Well, ya, that I'm somewhere in the middle"

Theme: *Instructors Struggle to Keep Up*

Andrea	Chris
"From my perspective, it's not going very well at all. From the student's perspective, I think it's going okay."	"Midterm [1] was generally done poorly (seems like it was too long). Average was 50, which isn't great. Got some anonymous feedback after criticizing the length."
"Because it's the first time I've taught it … I'm constantly scrambling to, to learn the material and try and stay 15 minutes ahead of the students right now, which is not a very comfortable place to be in…. … I just can't seem to catch up."	"This course has been a bit rough around the edges."

Theme: *Monitoring Discussion Forums*

Andrea	Chris
"I've actually been pretty happy with the types of questions and the number of questions."	"I haven't been answering that much It's [the forum] not been a big part of the course …If I cared … the past couple of weeks I've just been too busy to monitor it regularly, so I haven't been."
"My TAs are doing an excellent job of answering the kinds of questions that they can answer and leaving alone the questions that they can't answer, which is remarkably mature of them."	"[TA monitoring of discussion forum] I'm not doing that this term … I found … that requires a TA that has the right sensibilities… as well as making sure they're kind of in-sync with me… I've found that it's not worth the effort."
	"Place [for students] to ask questions in a more convenient manner ... They get to answer questions … I don't know that a lot of students who do this …. There are students who reference others' posts and I'm always kind of surprised by this."

Theme: *Understanding Students*

Andrea	Chris
"Students did demos of their projects during the last week of classes. Two interesting things came up: 1) they often emphasize new but simple concepts that we covered in class - like form validation … It was a useful reminder that the novice students need time to explore and work with even some of the simpler ideas in the course … It is a useful reminder of how many concepts in the course are new to the majority of the students. As I am re-thinking the course, I will pay more attention to these concepts."	"Multiple TAs reported the same student misconception (about asymptotic analysis) … I'm concerned because this is a prerequisite topic for the course, but I see why it's such a common misconception."
"It's always surprising, the students who have lots of background, how often they ask remarkably naive questions … They're missing some key components of how things fit together."	"I received anonymous feedback that the labs are much too difficult for students who are new to the material."
"He [TA] isn't at the point yet of understanding everybody has to take the path to get there and there's no magic one right way to learn.... That's okay… It's a phase we all go through where we think that we know. We are going to make it so much easier … because you know all the things that you need to do to get there, and now you can get rid of that stuff that was unnecessary	"Student performance on second midterm was better than first, but EngSci students improved much more than CS students. [I was] surprised, a little disappointed."
	"Midterm was generally done poorly (seems like it was too long). Average was 50, which isn't great."
	"Some of them were extremely worried so kind of anxious."

Andrea	Chris
and teach them only the stuff that actually matters. And, and then you realize that's not actually possible."	
"I have the luxury of having taught for enough years to feel like I understand the students a little bit."	

Scholarly Significance

Instructors tend to know what types of interactions and strategies help meet learning objectives and support students' academic needs. However, this knowledge does not always transfer to blended environments where the technology may present challenges that impact student learning experiences (i.e., struggling to monitor discussion forums). Traditional face-to-face teaching approaches may be less effective in such environments (Horspool & Lange, 2012). Keeping this in mind, it seems that instructors' ability to solicit student feedback, formally and informally helps them have a more accurate and meaningful view of students' experiences. Such views can then be used to help improve course(s) and teaching practices for current and future cohorts.

Although only two instructors were interviewed, our term-long study has identified some specific ways student feedback helped instructors improve their courses. For example, instructors emphasized the critical role student feedback played in understanding students and building trust. Efforts to ignore student experiences and not seek out their feedback will only make it difficult for instructors to provide a positive learning experience for students. Therefore, we argue that when instructors seek student feedback it is important to put aside their biases, which Chris struggled with, and address students' emotional needs to enable them to focus on learning and facts, which was a concern Andrea had. In addition, adopting a cross-disciplinary approach, as was done by our team, can help maintain objectivity because instructors would have access to new knowledge to help address student learning needs and improve teaching practice. Not doing so, will lead to "...circumstances in which objective facts [in our case student feedback] are less influential in shaping public opinion [or instructor opinion] than appeals to emotion and personal belief" (Wells, 2019, para 1).

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