Using a Student Consultant in a Computer Science Course: An Experience Report

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ABSTRACT

This paper describes the experience of using a student consultant in a sophomore level computer science course. A *student consultant* is a student who is not enrolled in the course, but attends selected class sessions and provides feedback on the in-class experience to the instructor, with the goal of improving some aspect of the course. In this paper we describe our experience with such a program from the point of view of both the instructor and the student consultant. We provide our views of the experience with the dual goals of making student consultant programs better known within the computer science education community, and to provide guidance and insight to those who may wish to use such a program themselves.

Keywords

student consultant; instructor feedback

1. INTRODUCTION

In this paper, we describe the experience of using a *student consultant* in a computer science course. A student consultant is a student who is not enrolled in the course, who attends at least one class session a week and provides the instructor with feedback on the course, focusing on student responses to the material. The student consultant and instructor work together in order to explore and improve some aspect of the course.

Unlike a TA, the student consultant's job is not to help students with the homework. It is to observe the atmosphere and dynamics of the class and to record these observations in detailed notes. Meetings with the instructor serve to communicate the student's observations and to provide space for the instructor to talk out their thoughts about the class. Just as the act of explaining a software bug to someone can illuminate the fix, simply talking about how this week's class went with the student consultant can help the instructor debug their class.

ITiCSE '16, July 09 - 13, 2016, Arequipa, Peru

ISBN 978-1-4503-4231-5/16/07…$15.00

DOI: http://dx.doi.org/10.1145/2899415.2899434

Both the instructor and student consultant found this experience to be both useful and rewarding. We report on it here in order to make the greater computer science education community aware of student consultants in general, and to report what we learned from the experience. As the use of student consultants is relatively new within the computer science community, this paper is not a rigorous study of student consultant use within computer science, but rather a subjective report of our experiences as both instructor and student.

In this paper, we describe student consultant programs in general, and then describe the specifics of how we adapted the idea for this particular course. This is followed by an in depth discussion by both the instructor and student consultant of the benefits and difficulties of the program, and recommendations for those who wish to implement such a program in their own courses.

2. RELATED WORK AND BACKGROUND

Student consultants have been used by a variety of disciplines, at a variety of institutions. Our program was modeled after the student consultant program developed by Alison Cook-Sather at Bryn Mawr College, which has been running there as the Students as Learners and Teachers (SaLT) program since 2006 [3]. Similar programs include the Students Consulting on Teaching Program (SCOT) at Brigham Young University [12], the Students Consulting on Teaching Program at the University of Lincoln [4], and the Student Observer Program at Carleton College [2].

The SaLT program matches instructors who are interested in exploring the in-class experience of a course with student consultants for a semester. The student consultant attends and observes one class a week, taking detailed notes on what is happening in the class. They record both what the instructor is doing, and how the students are responding. The instructor and student consultant meet weekly to discuss the class session the consultant observed. These discussions include both a factual recounting of what the student consultant observed, and their subjective assessment of how the students reacted or any issues with the lesson.

Cook-Sather describes the goals of the program at the institution level as supporting faculty and students in exploring pedagogical questions and improving classroom dynamics, but also to foster constructive dialogue between students and faculty, and to encourage general dialogue between students and faculty about teaching and learning [3]. At the instructor and course level, the goals may vary widely within the general framework of course and pedagogical improve-

ment. Given this, the details of what the student consultant records during class, and the focus of their discussions with the instructor may vary widely, and must be defined by the instructor and consultant themselves.

3. THE SETTING

In this section, we describe the basics of the course that the student consultant observed, as well as the goals the instructor and consultant had going into the program.

3.1 The Course

Our course was an Introduction to Computer Architecture course, covering MIPS assembly, digital logic, the data and control path, pipelining and the memory hierarchy. This course is a required course for the Computer Science major at the institution at which it was taught, and is usually taken by sophomore and junior level students. Thirty-seven students were enrolled in the course (a fairly large course size for this institution). The course was taught at a small liberal arts college.

The course was taught using peer instruction. Peer instruction is an active learning technique that has been well documented to increase student's conceptual understanding of topics [5], and has been increasingly used in computer science [11, 10, 9, 6, 13, 8]. Using peer instruction, throughout the lecture the instructor displays a multiple-choice question, with one correct answer and two to four distractor answers. Students first vote individually on an answer, using an electronic clicker device [1]. They then discuss the question in small, assigned groups, and after a brief discussion, the group votes on a single answer.

During most class periods in this course, the instructor would lecture for a short amount of time to introduce a concept, and then put up a clicker question on the material she had just covered. Students would vote individually, discuss, and revote in their groups. After this, a single discussion group would be responsible for telling the class about their discussion, what answer they selected, and why. The instructor would discuss the answer, and answer any student questions. When the discussion was resolved, the instructor would continue to the next mini-lecture. This would generally repeat around five to eight times per fifty minute class.

3.2 Instructor Goals

The instructor had previously taught this course twice before. She was particularly interested in trying to improve student engagement with the material, as feedback on the course previously had indicated some students found the material dry or uninteresting. She also wanted to know what material was particularly confusing to the students, and how to make material more comprehensible in general. After discussion with the student consultant, they decided to focus on how students responded to clicker questions, as this would give a concrete opportunity for the student consultant to observe student reactions to material.

3.3 Student Consultant Goals

The student consultant took on this job in his last undergraduate semester.

Since the student consultant was and is interested in pursuing teaching as a career, he saw the job as a way of getting a behind-the-scenes-look at the process of teaching. Being able to participate in the running of a real class was a major draw for this student consultant.

Another hope was that he could, by working with the instructor, improve the classroom experience for students. This student consultant had worked a variety of campus jobs tutoring for similar classes in the CS department, and took on this role with a similar perspective and set of goals.

At the outset of the program, the student consultant had goals that were, in part, activist. Though he overall had an excellent, encouraging introductory CS experience, he recalled certain things about it that he had found frustrating, confusing, or discouraging. He wanted to prevent other students from encountering the same difficulties.

4. THE EXPERIENCE

In this section, we discuss the details of our use of the student consultant program within this course.

4.1 Selecting the Student Consultant

In selecting the student consultant, we were looking for an upper level computer science major who was not currently taking any other courses with the instructor. Since one of the instructor's goals was to explore student understanding of the course material, she felt it was important to have a student consultant who had either taken the course, or who had enough other computer science experience to understand the material in context. This differed from the original SaLT program, in which students were frequently consultants for subject areas they had no prior experience with.

Following the SaLT model, we selected a student who was not taking any other courses with the instructor, as we did not want any situations in which the student consultant might feel that providing negative feedback on the course could have potential repercussions.

In order to find students, we put out an open call advertising the position to all computer science majors. We selected a student consultant who was a senior computer science major, and who expressed an interested in pedagogy and teaching as a future career. The student consultant had previously taken this course from the instructor.

The student consultant was paid an hourly wage similar to that of other student workers (tutors, graders, etc.) in the CS department.

4.2 Training and External Support

This took place as part of a pilot program using student consultants at our institution. As a result, the role of the student consultant may have been less clearcut than if this was a more established program.

At the beginning of the semester and several times throughout the semester, the student consultant and the instructor had meetings with the other instructor and student consultant in the student consultant program, as well as the head of their institution's Teaching Center (who was responsible for starting the program). Usually these meetings had breakout sessions with just instructors or just student consultants, as well as meeting with the entire group.

At the beginning of the semester, these meetings had more of a training aspect, with an external expert training the student consultants on note taking, and meeting with both instructors and consultants to discuss their goals for the semester, and how best to achieve those goals. Later meetings offered instructors and consultants an opportunity

to reflect on how the process was going, and offer each other suggestions for improvements.

4.3 Classroom Observation and Weekly Discussions

The student consultant attended one of the three classes each week. At the beginning of the course, the instructor introduced him to the students, along with a brief description of his role as student consultant. Because one of our goals was to focus on student discussion, the student consultant sat in a different place in the classroom in each class he attended, in order to observe different groups of students.

During class, the student consultant took detailed notes, with the time, what was happening in the lecture, and his thoughts, recording what was happening in class every three to five minutes. These notes included specifics of the small group student discussions that he observed, including approaches students took to solving problems, how difficult they found particular problems, and general reactions to material and group dynamics. He also recorded aspects of classroom discussion, including questions asked of the instructor, and student reactions to her answers (sample notes pictured in Table 1).

After class, the student consultant typed up and clarified his notes, and then shared them with the instructor before their weekly meeting, so they both had a written record of the class. In their weekly meeting, they went over the notes together, and discussed what had happened in the class and student reactions, as well as the student consultant's subjective assessments of class comprehension and engagement. During these meetings, the instructor usually had both her lecture slides and the student consultant's notes up on her computer screen, to get as comprehensive a picture as possible of what was happening at a specific point in class. The instructor would frequently take notes in relevant places in her slides, or revise slides during the meeting based on their discussion.

These meetings generally lasted about an hour, and the topics discussed varied widely in specificity, from comments like "I noticed that some of the students seemed confused at this point" or "I felt this was a very engaging class overall", to in depth discussion of what distractor answers would best illustrate common student misconceptions in a peer instruction question. The student consultant would also frequently ask the instructor what her perception of something that had occurred in class was, or the instructor would ask the student consultant what his personal experience learning specific material had been. Discussions tended to be grounded in specific lecture slides or course materials, but also touched on student reactions to the course as a whole, and occasionally touched on what could be added to materials like labs or problem sets in order to aid student understanding of specific points.

4.4 Midterm Feedback

Following the SaLT model, halfway through the course, the student consultant lead a class discussion on how students felt about the course, as well as having the students fill out a standard, anonymous questionnaire on the course. The instructor was not present for this discussion, but the student consultant wrote up and conveyed the key points.

Since the student consultant made it clear that all feedback was welcome, that no one's name would be shared if they didn't want it to be, and because he was not the instructor, the discussion ended up being quite frank. Even students who were often quiet in class spoke up – if they were less comfortable participating in the group discussion, they approached the student consultant immediately afterwards. While the discussion was frank, it was not largely negative. When one student complained about some aspect of the class, another would pipe up just to say how much they enjoyed that aspect. For example, the coursework included written problem sets as well as lab assignments: some students felt some of these problem sets were too easy, and had "busy work" qualities, while an equal number found them to be useful practice for the tests.

It's common for students to have different opinions about a course, but what the midterm discussion did was get them talking to each other about it. It's not likely that any such conversation would have happened independently. We feel that having the opportunity to engage with view contrary to their own made students more aware that others found value in parts of the course that they did not. Additionally, having a structured discussion instead of an anonymous survey enabled the student consultant to ask specific follow-up questions, and also got students to give higher-quality feedback, not just noting problems but talking about solutions.

Student response to the midterm class discussion was overwhelmingly positive. Students said that merely setting aside time for the discussion made them feel that the instructor cared about their experience of the course, and also that they felt more ownership over the course. Some found it cathartic to be able to address issues that they had not had a forum for before. One student expressed surprise that this was not standard practice in every class.

4.5 Student Consultant as Intermediary

An unexpected outcome of having a student consultant who was known to the students was that he became a course representative who may have seemed more approachable than the instructor to some students. One significant outcome of this was that at one point a student who wished to remain anonymous to the instructor approached the student consultant to report observing cheating on an in-class exam. Students also took the initiative to approach the student consultant with feedback about the course.

5. DISCUSSION AND RECOMMENDATIONS

What follows is a subjective assessment by both the instructor and the student consultant about their experience with the student consultant program.

5.1 Benefits

Both the instructor and student consultant had a very positive experience with the program. Below they discuss specific aspects which they found especially beneficial.

5.1.1 Instructor

- **In depth discussion of lecture/course activities.** Typically, instructors develop lectures on their own, and get very little feedback on the granularity of individual lectures, examples, or discussion questions. The instructor gets feedback on the course as a whole from students at the end of the course, and individual students may ask questions or comment on a specific aspect of a lecture, but it is rare to get a chance to

Table 1: Sample Student Consultant Notes

Time	Observation	Reflection
2:43	More slides on how MIPS translates to machine code – shamt, funct, etc. You do a demo translation. You emphasize that the order of the operands is switched in machine code. Someone in front of me (S) is shaking her head.	I think she was intimidated by the amount of information on the slide.
2:45	G asks "What is SA". You answer "shift amount" and explain shifts.	I wonder about whether people have seen shifts before. I don't think it's all that hard to pick up; a short visual explanation like yours seemed to work.
2:49	You complete the demo, emphasizing labor-saving tricks when converting numbers to binary ($17 = 16 + 1$, $18 = 17 + 1$). You note that the hex value in funct is bounded by available space.	I really like these sorts of tricks – I think they can create engagement by being a way to save time through understanding. I wonder if that's just me?
2:51	Clicker Question: Now you do the reverse! (translate from machine code to MIPS). Some banter while everyone crunches the numbers. People are whispering about the problem.	Interesting how everyone collaborated on this.
2:54	Discussion. Guy in S's group is mostly explaining; S is asking "but why?" a lot. Other student in their group is mostly silent.	Discussion was sort of a continuation of working on the problem, since people were doing it collaboratively to start with. But there was a lot more talking once it was official.

analyze how effective an individual class period was in terms of student engagement and understanding. Getting a chance to discuss this was very rewarding, and lead to more in depth analysis of how to convey specific information.

The instructor is a relatively new instructor, and was in her third year of teaching when participating in this program. As such, she found getting in depth feedback on her teaching to be especially useful.

- **Immediate reflection and revision of course materials.** Instructors are constantly revising course content based on its prior success or lack thereof. However, given busy schedules, this revision frequently does not occur until the next time the course is taught, which may be a semester, a year, or even multiple years later. Having a dedicated weekly time to go over a recently taught class, reflect on it, and make changes to the materials meant that changes were made while the experience of teaching the content was still recent.
- **Insight from a novice perspective.** A common issue in teaching is that novices and experts simply conceptualize material differently [7]. Since the student consultant had learned the information himself only a year prior, he was able to offer an opinion that combined a basic knowledge of the material with a recent memory of what about it had been difficult or confusing to learn.
- **Records of individual group discussion.** The observed course heavily featured student discussion in small groups, as well as full class discussion. As the course was taught in a lecture hall, it was difficult for the instructor to observe what individual student groups were discussing in class, especially those towards the back of the classroom. Having the student consultant observe and record individual group discussion meant that the instructor got a window into how students were approaching and solving the posed problems.

The instructor found this information very enlightening. Some questions that the instructor felt were too "plug and chug" (and was thinking of cutting) were actually leading to interesting discussions on how to solve problems, while other questions were too easy or had distractor answers that gave the answer away. Not only did this allow the instructor to improve individual questions (and give her fodder for good distractor answers based on actual student misconceptions), but it also gave her valuable insight into how students were actually approaching problem solving, and what they found misleading or confusing.

- **Records of full classroom discussion.** It was surprisingly helpful for the instructor to have a written record of all class discussion from a class period. Being able to review student comments and questions while reviewing and revising the lecture allowed for reflection on discussion details that the instructor otherwise would likely not have remembered. It also meant that over the course of the semester, there was a clear record of who talked in class: which students were more likely to ask questions or spearhead discussions. Working purely as an observer allowed the student consultant to record details of classroom interaction that the instructor missed, allowing for a much clearer picture of classroom activity.

5.1.2 Student Consultant

- **Reflection on content and one's own learning process.** Seeing a fresh round of students get exposed to concepts he was already familiar with, the student consultant realized that he wasn't actually so familiar with them. Specifically, though he remembered big ideas, he had forgotten some of the glue that held them together. Discussing students' reactions to concepts with the instructor, he discovered new approaches and understood subtleties that he missed the first time around.

- **Reflection on others' learning processes.** As noted in the 'Goals' section, at the outset of the program one of this student consultant's goals was to use his input into the class to guide its students around certain obstacles and help them avoid making certain mistakes. This goal turned out to be fairly misguided, because (as this student consultant realized) his experience with Computer Science classes was hardly universal. Listening to the students, especially at midterm review time, he found that the range of difficulties they had and the range of triumphs they experienced didn't match his preconceptions very well. He found that the student consultant note-taking process – sitting in the lecture hall, being as attentive as possible to the atmosphere of the room, recording it in detail, trying to think from the perspective of 37 other people – quickly expanded his ideas about students' experiences of Computer Science classes.

5.2 Difficulties

While this experience was positive overall, certain aspects of it were difficult or uncomfortable at times. We describe these below.

5.2.1 Instructor

- **Facing classroom failures.** There are many reasons a particular class session may not have gone as well as possible. Working with a student consultant means spending time dwelling on those failures. It is not pleasant to be reminded that the back row of your class was reading their phones instead of paying attention. There were times when a lesson didn't work and there was no clear reason why or how to fix it.

- **Perceptions of instructor competence.** On the first day of class, we introduced the student consultant to the class, and explained a little bit about the program. Overall, this was a positive. Students reacted well to the idea that the instructor wanted their feedback on the course, and was receptive to their ideas. However, there is the danger of students questioning the instructor's competence because they are asking for this kind of feedback. This is especially relevant to instructors who are women or part of other underrepresented groups in computer science.

- **Students wanting too much ownership.** Students may interpret asking for feedback as a guarantee that the instructor will implement their specific proposed changes, or feel upset or ignored if the instructor does not make specific changes.

5.2.2 Student Consultant

- **Bringing up subjects in meetings with the instructor.** Since this student consultant wasn't used to having a partner-to-partner, as opposed to mentor-to-student, relationship with his professors, he initially had some difficulty taking the initiative to bring up topics on his own during the weekly meetings with the instructor. Even though the instructor was committed to discussion and examining her pedagogy, a good discussion partner needs to bring in material from their own point of view. The rigorous note-taking format helped with this, since putting what you noticed in writing forces you to talk about it.

- **Dealing with bad stuff that can't be helped.** No class will be perfect, or maybe even good, for every student. Doing the midterm review exposed this student consultant to a wide range of feedback, including students who were unhappy with the course for very different reasons, some of which were things we could change, some of which weren't, some of which were hard to tell.

5.3 Recommendations

We provide recommendations for both instructors and student consultants interested in implementing a similar program in their own courses below.

5.3.1 Instructor

- **Have a specific thing to talk about, but don't be afraid to discuss other things as well.** Having a specific aspect of the course to focus on (in this case, clicker questions), gave the initial discussions between the instructor and student consultant a natural focus. As the student consultant and instructor became more used to these discussions and their partnership, they were able to move on to discuss other aspects of the course as well.

- **Be open to whatever form feedback takes.** Going into this experience, the instructor pictured making drastic changes to the course based on the student consultant's feedback. While this did not happen, the instructor felt she left the experience with a much clearer, in depth picture of what was happening in the course and what students struggled with. Instead of large, sweeping changes she ended up making a large number of small changes to course materials, based on this detailed information of how students were reacting in class.

5.3.2 Student Consultant

- **Listen when meeting with the instructor.** You're there to provide your viewpoint, but also to get an actual conversation going. In order to do that, you need to be responsive. Don't just deliver a list of facts, or read off your notes blow-by-blow.

- **Spy in class.** When the class isn't in lecture mode (working in small groups, in pairs, etc.) walk around and see what's going on. Even when it is, take notice of how and when students seem engaged, whether a whispered conversation is actually confused student asking their friend for help, who's raising their hand to ask questions and who's not. This student consultant found that he sometimes got stuck just recording what was happening on the slides (leading to notes reading "3:55 – Covered topic A. 4:00 – Covered topic B") but it's more important to record stuff the instructor isn't focusing on, since that's what they know the least about.

- **Have the student consultant be a paid position.** The student consultant needed to work a certain number of hours every week in order to meet his financial

plans (He was completing his last semester as a part-time student for financial reasons). If the job weren't paid, the student consultant might not have been able to take it on.

5.4 Customization to Computer Science

There were a couple of key issues in using this program within the computer science domain. We reflect on these below.

- **Having a student consultant who was familiar with the course material.** Since one of the instructor's main goal for this project was to try to make material more accessible to students, she felt it was important to have a student consultant who already understood the material. Having a consultant who had taken the course already allowed the instructor and consultant to engage in a close reading of lecture materials such as slides and clicker questions, and discuss details as minute as wording of slides and examples used in class. While instructors who are less focused on student comprehension issues in the course may find consultant understanding of the material less important, the student consultant having a basic knowledge of computer science concepts was critical to giving informed, detailed feedback on the course.

  The student consultant we selected had previously taken the course with the same instructor - this was unavoidable as no other instructor had taught the class in the previous two years. This may mean the student consultant was more likely to think about concepts in similar ways as the instructor. Since the student consultant had already taken the course, he could also provide insight on the outside of lecture aspects of the course such as lab assignments and problem sets.

- **Emphasizing the student consultant and instructor were on the same team.** As a relatively young, female instructor in Computer Science, the instructor was especially aware of the possibility of students questioning her competence. She discussed this with the student consultant before the midterm feedback session, instructing him to be aware of it in the discussion, and letting him know that while she solicited critical feedback from students on the course, she wanted to make sure her basic competence as an instructor and computer scientist was respected during the discussion.

6. CONCLUSION

Our participation in the student consultant program was a valuable experience for both the student consultant and instructor. While difficult at times, the program had many benefits, including a reflection on pedagogy in general, in computer science, and in this specific course. The program resulted in an improvement in course materials for future offerings of the course, and had a positive response from students in the course.

We provide this experience report in order to make computer science instructors aware of the benefits offered by using a student consultant in their courses, and to provide information on our experience to those who may wish to try.

7. ACKNOWLEDGEMENTS

Thanks to Steven Volk of Oberlin College and Alison Cook-Sather at Bryn Mawr College for their guidance throughout the student consultant experience. Thanks to Dean Timothy Elgren of Oberlin College for funding this program.

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