

Using the Classroom Performance System in Computer Sciences 303

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Introduction

This research study examined the effects on students' attentiveness, attitudes, self-confidence, and content mastery when instructors used the Classroom Performance System (CPS) to get continuing feedback from students in an introductory computer sciences course at the University of Texas at Austin. Using a wireless touch pad, students responded immediately to instructors' multiple-choice, true-false, and other close-ended questions about problem solving, facts or processes, or opinions. Instructors could choose whether to display simply the correct response or also a summary of the class's performance, with histograms and detailed reports.

Chiu and Woods (2002) suggest that a principal advantage of CPS is that it provides instructors instant feedback about what students are understanding and how they are participating, assisting instructors in making important decisions such as when to introduce new points, how to design and schedule assignments, what background knowledge to provide, how to anticipate misconceptions, and how to help students incorporate past material (Lopez-Herrejon & Schulman, 2004). Such instant feedback has the dual advantage of keeping students engaged and letting them know where they stand compared to their classmates (Chiu & Woods, 2002).

The primary research questions concerned whether using CPS increased students' engagement, facilitated their learning, and contributed to their progress in the course.

Methodology

The subjects of the study were forty-four students enrolled in C S 303W, Elements of Computers and Programming, at UT Austin during summer 2004. The course consisted each week of two lectures by the instructor and one discussion session led by the teaching assistant. For approximately half of the lectures, the instructor used the Classroom Performance System to present review questions and provide feedback on the correct answer and the performance of the class. For the remaining lectures, the instructor presented review questions on paper and provided only the correct answer as feedback. The teaching assistant used CPS during almost every discussion session.

Qualitative data were collected using classroom observations, student surveys, student rating scales, a student focus group, analysis of minute papers, analysis of CPS performance, and analysis of final exam performance.

Two researchers conducted classroom observations (Appendix A) of lecture and discussion sessions from the fifth through eighth weeks of the eleven-week course to document the general behavior of the class, including student behavior at specified time points during the class, the types of questions students asked, and the types of questions the instructor asked. These observations were classified according to whether CPS was used during the session.

During the first week of lectures, the students filled out a pre-course survey (Appendix B) concerning their expectations of engaging in various activities in order to perform well in the course. Survey items were taken from the Metacognition and Self-Efficacy scales of the Motivation for Strategies Learning Questionnaire (MSLQ). Students were asked to rate how true each statement was of them, using a seven-point scale from 1 = *Not at all true of me* to 7 = *Very true of me*. The same items were used in a post-course survey (Appendix C) during the last week of lectures to determine the degree to which the students believed they engaged in these behaviors during the course. Additional items on the post-course survey addressed the students' feelings toward the use of CPS in the lectures and in the discussion sessions to examine the differences between students' perceptions of the usefulness of CPS in those situations.

At the beginning and end of each class session, students completed a one-question rating form (Appendix D) to reflect on how confident they were about their understanding of the upcoming lesson and then how accurate they had been in their prediction.

During the eighth week of class, researchers used a focus group (Appendix E) of three females and two males—recruited the week before with the incentive of a free lunch—to hear about their experiences with CPS during the course.

After each lecture, students were asked to write down any remaining questions they had from the day's lecture, producing a document referred to as a "minute paper." Eventually this exercise also became a way for students to express concerns and criticisms about the content and pace of the lectures.

Students' content knowledge was measured through their performance on CPS questions as well as on the final exam, whose questions were coded as to whether they related to a topic that was presented using CPS.

Results

Classroom Observations

For both types of lecture days—CPS and paper—the class appeared attentive throughout, with observed individual inattentiveness sometimes beginning 30 or 40 minutes into the 75-minute lecture. A high level of attentiveness was observed when a problem was being explained on the chalkboard or when the students were working through a problem, regardless of whether CPS was used, as determined by the number of students who were taking notes about exercises posed during the lecture or discussion sessions.

Student Surveys

A t-test of mean differences was performed to compare students' scores on items from the pre- and post-course surveys of their expectations and subsequent behaviors. On the metacognition and self-efficacy scales, there were significant differences ($p < .05$) between the beginning and conclusion of the course, with lower total-score values on both scales, as shown in Tables 1 and 2.

Table 1. Descriptive Statistics for Pre-Course and Post-Course Surveys:
Metacognition and Self-Efficacy Scales

| | Mean | N | Std. Deviation | Std. Error of the Mean |
|---------------------------|-------|----|----------------|------------------------|
| Pre-course Metacognition | 43.5 | 24 | 12.762 | 2.605 |
| Post-course Metacognition | 37.0 | 24 | 14.096 | 2.877 |
| Pre-course Self-Efficacy | 37.09 | 23 | 7.982 | 1.664 |
| Post-course Self-Efficacy | 33.26 | 23 | 10.037 | 2.093 |

Table 2. Paired Samples t-Test Results for Differences in Pre- to Post-Course
Metacognition and Self-Efficacy Scales

| | Paired Differences | | | | | t | df | Sig. (2-tailed) |
|------------------------|--------------------|----------------|-----------------|---|-------|-------|----|-----------------|
| | Mean Difference | Std. Deviation | Std. Error Mean | 95% Confidence Interval of the Difference | | | | |
| | | | | Lower | Upper | | | |
| Pre-Met— Post-Met | 6.50 | 11.139 | 2.274 | 1.80 | 11.20 | 2.859 | 23 | .009 |
| Pre-Self— Post-Self | 3.83 | 6.555 | 1.367 | .99 | 6.66 | 2.799 | 22 | .010 |

Two items from the metacognition scale showed significant differences between the pre- and post-course surveys:

- “I plan to try to think through a topic and decide what I am supposed to learn from it rather than just reading it over when studying for this course” and
- “If I get confused taking notes in class, I plan to make sure I sort it out afterwards.”

The first item had a mean difference decrease of .880, $t(24) = 2.240$, $p = .035$, while the second item had a mean difference decrease of 1.400, $t(24) = 3.742$, $p = .001$. These significant differences may explain the overall decrease of 6.50 on the metacognition scale from the pre- to the post-course surveys.

One item from the self-efficacy scale showed a significant difference between the pre- and post-course surveys: “Considering the difficulty of this course, the teacher, and my skills, I think I will do well in this class.” This item had a mean difference decrease of 1.080, $t(24) = 3.166$, $p = .004$. This difference may explain the overall decrease of 3.83 on the self-efficacy scale.

A t-test of mean differences was performed to compare students’ pre- and post-course perceptions of the course overall and the use of the Classroom Performance System, using those items aimed at differentiating students’ perceptions of the lectures from their perceptions of the discussion sections. Items presented a five-point Likert scale from $1=Strongly Disagree$ to $5=Strongly Agree$.

Four sets of items showed significant differences in students' perceptions of the lectures and the discussion sections:

- “The *lecture sessions* were helpful to my learning of the course content.” ($M = 3.36$, $SD = 1.036$)
- “The *discussion sessions* were helpful to my learning of the course content.” ($M = 1.96$, $SD = 1.274$)

($t(24) = 5.170$, $p = .000$)

- “The questions asked with the CPS *during lecture sessions* helped me learn better.” ($M = 2.48$, $SD = 1.085$)
- “The questions asked with the CPS *during discussion sessions* helped me learn better.” ($M = 1.84$, $SD = 1.028$)

($t(24) = 3.361$, $p = .003$)

- “The CPS helped me realize how much I understood about what was being covered in the lecture sessions.” ($M = 2.76$, $SD = .879$)
- “The CPS helped me realize how much I understood about what was being covered in the discussions sessions.” ($M = 2.36$, $SD = 1.075$)

($t(24) = 2.309$, $p = .030$)

- “The CPS helped me realize how I compared to my classmates' performance in lecture sessions.” ($M = 3.04$, $SD = .908$)
- “The CPS helped me realize how I compared to my classmates' performance in discussion sessions.” ($M = 2.54$, $SD = .977$)

($t(23) = 2.627$, $p = .015$)

These results indicate that students' perceptions of the discussion sessions were different from those of the lectures, with their perceptions of the discussion sessions and CPS use in them, on average, less positive than their perceptions of the lecture sessions.

Rating Scale

The relationship between students' confidence level about their understanding of the material being taught in a given class meeting and their self-reported level of accuracy was examined (Table 3). Across all eleven days when CPS was used, approximately 20% of students were very or extremely confident about their understanding of the course material, almost 35% were not at all or a little confident, and most students (45%) reported they were somewhat confident. Concerning the accuracy of their prediction, a similar pattern emerged as approximately 33% reported they were very or extremely accurate in their prediction, 25% reported they were not at all or a little accurate, and 43% reported they were somewhat accurate. Among those students who reported very little accuracy, most had no, little, or moderate confidence in their understanding. Almost all the students who were very or extremely confident in their understanding reported they were somewhat, very, or extremely accurate in their rating.

Table 3. Cross-Tabulation of Self-Reported Confidence by Self-Reported Accuracy across All CPS Sessions

| N Row % Column % Total % | Not at All Confident | A Little Confident | Somewhat Confident | Very Confident | Extremely Confident | Totals |
|-----------------------------------|-----------------------------|-------------------------------|-------------------------------|------------------------------|-----------------------------|---------------|
| Not at All Accurate | 1 7.7% 6.7% 0.4% | 8 61.5% 10.0% 2.9% | 4 30.8% 32.5% 1.5% | 0 0.0% 0.0% 0.0% | 0 0.0% 0.0% 0.0% | 13 4.7% |
| A Little Accurate | 8 14.3% 53.3% 2.9% | 21 37.5% 26.3% 7.6% | 24 42.9% 19.5% 8.7% | 3 5.4% 6.7% 1.1% | 0 0.0% 0.0% 0.0% | 56 20.4% |
| Somewhat Accurate | 5 4.3% 33.3% 1.8% | 30 25.6% 37.5% 10.9% | 59 50.4% 48.0% 21.5% | 21 17.9% 46.7% 7.6% | 2 1.7% 16.7% 0.7% | 117 42.6% |
| Very Accurate | 0 0.0% 0.0% 0.0% | 19 26.0% 23.8% 6.9% | 34 46.6% 27.6% 12.4% | 16 21.9% 35.6% 5.8% | 4 5.5% 33.3% 1.5% | 73 26.5% |
| Extremely Accurate | 1 6.3% 6.7% 0.4% | 2 12.5% 2.5% 0.7% | 2 12.5% 1.6% 0.7% | 5 31.3% 11.1% 1.8% | 6 37.5% 50.0% 2.1% | 16 5.8% |
| Totals | 15 5.5% | 80 29.1% | 123 44.7% | 45 16.4% | 12 4.3% | 275 100.0% |

Focus Group

Two important themes emerged from the focus group. First, the students found CPS was very helpful because of its immediate feedback with anonymity. Not only did CPS let the students know whether they got a particular question right, it also allowed them to see how they compared to the rest of the class without feeling pressure, because their anonymity was preserved. CPS appeared most useful when the instructor provided explanations along with the answers.

Second, the students found the use of CPS in discussion sessions not to be very helpful because it was used primarily as a quizzing tool rather than as a learning tool, a device for asking difficult questions that were not being explained. Students felt that CPS replaced some of the real-time student-instructor interaction that discussion sessions need.

Minute Papers

From the minute papers (Appendix F) it seems clear that the lectures aided the understanding of those students who had previously read through the material but did not help or even hindered those students who had not.

CPS Individual Performance

Analyses were conducted on individual performances using the CPS system (Table 4). On specified days, in lecture and in discussion, students were presented a series of two to six questions as review for the material they had recently covered in class or read in their texts, and the mean percentage correct was computed for each day, covering ten days. Students generally did not score better than 50% correct on review questions posed through the CPS.

Table 4. Descriptive One-Sample Statistics for CPS Scores by Class Session

| | N | Mean | Standard Deviation | Std. Error of the Mean |
|-------|----|-------|--------------------|------------------------|
| CPS1 | 20 | 51.00 | 27.891 | 6.237 |
| CPS2 | 21 | 57.19 | 33.668 | 7.347 |
| CPS3 | 20 | 27.50 | 22.798 | 5.098 |
| CPS4 | 3 | 11.00 | 19.053 | 11.000 |
| CPS5 | 22 | 24.18 | 32.840 | 7.001 |
| CPS6 | 23 | 32.57 | 16.981 | 3.541 |
| CPS7 | 22 | 49.95 | 24.872 | 5.303 |
| CPS8 | 21 | 31.67 | 28.895 | 6.305 |
| CPS9 | 20 | 30.00 | 29.912 | 6.689 |
| CPS10 | 18 | 11.11 | 21.390 | 5.042 |

The correlation between the mean CPS scores and final exam scores was .116, which was non-significant.

Table 5. Correlation between CPS Scores and Final Exam Scores

| | Mean of CPS Scores |
|---------------------------|---------------------------------------|
| Mean of Final Exam Scores | Pearson Correlation Coefficient: .116 |
| | Significance (two-tailed test): .600 |
| | N: 23 |

Final Exam Performance

The instructor coded the final exam questions as either related or not related to CPS review questions, allowing computation of an overall percentage correct score for each group of questions (Table 6). A t-test was conducted to determine if there was a significant difference in students' overall performance on the two types of final exam questions. The mean percentage

correct for the questions on CPS-tested topics was 77.68 and for the other questions was 88.26, resulting in a significant difference, $t(22) = -3.982$, $p = .001$ (Table 7).

Table 6: Descriptive Paired Samples Statistics for CPS- and Non-CPS-Related Final Exam Items

| | | Mean | N | Std. Deviation | Std. Error of Mean |
|--------|-----------------|--------|----|----------------|--------------------|
| Pair 1 | CPS-Related | 77.681 | 23 | 14.5013 | 3.0237 |
| | Not-CPS-Related | 88.261 | 23 | 10.2090 | 2.1287 |

Table 7: T-test for Mean Difference in CPS- and Non-CPS-Related Final Exam Items

| | Paired Differences | | | | | t | df | Sig.(2-tailed) |
|--------|--------------------|---------|------------|----------------------|-------|--------|----|----------------|
| | Mean | SD | Std. Error | 95% Confidence Intvl | | | | |
| Pair 1 | 10.5797 | 12.7412 | 2.6567 | Lower | Upper | -3.982 | 22 | .001 |

No significant differences were found in mean scores for the two types of final exam questions across the five demographic variables available from the pre-course survey: sex, college, GPA, prior computer experience, and prior CPS experience

Conclusions

While students found CPS very beneficial during lectures because it provided immediate feedback and eased the pressure to participate verbally, they felt that it didn't help them in their discussion sessions because using it often replaced interaction between them and the instructor. This finding is consistent with student feedback that using CPS along with interaction with the instructor was the most helpful way to help them learn material. Students reported that CPS worked better with conceptual than with problem-solving questions.

Students generally failed to achieve better than 50% correct on review questions presented through CPS, though it should be noted that they were not graded on the correctness of their responses but only on whether they participated. Students performed better on final exam questions not covered by CPS review questions than on those covered by CPS. However, this finding should be viewed with some caution because the classification of the final exam questions (for example, problem-solving vs. recognition) was unknown.

Recommendations for Future Research

Questions remain for further research. Would students' performance on questions presented through the CPS improve if they were offered an external reward? Would their performance be affected by different types of questions? What types are most appropriate to use with CPS? What would be the impact, on student learning and performance, of reducing their anxiety and increasing the feedback they receive through CPS?

References

Chiu, C. B., & Woods, H. A. (2002). A wireless system for classroom teaching. Retrieved June 8, 2004 from <http://www.ph.utexas.edu/~ctalk/talks/march25.htm>

Lopez-Herrejon, R. E., & Schulman, M. (2004). Using interactive technology in a short java course. Retrieved June 8, 2004 from <http://www.utexas.edu/academic/cit/gallery/utprofiles/cps/java.html>

Appendix B Pre-Course Survey

PART I.

INSTRUCTIONS: In the IDENTIFICATION section of the scan sheet write in your ID. Then darken in the letters and numbers in each column that correspond to the letters and numbers of your ID. This information will be used to match your survey results to other information you provide throughout the semester. Once all the information has been collected, all personally identifying information will be removed and will in no way be used or released.

The following questions ask you for information that describes characteristics about yourself. This information will be combined with those of your classmates to analyze general patterns. Use the scale underneath each question to indicate your answer on the scan sheet.

1. In what school or college are you enrolled?

- 1 = School of Architecture
- 2 = Red McCombs School of Business
- 3 = College of Communication
- 4 = College of Education
- 5 = College of Engineering
- 6 = College of Fine Arts
- 7 = College of Liberal Arts
- 8 = College of Natural Sciences
- 9 = School of Nursing OR College of Pharmacy
- 10 = School of Social Work

2. What is your class rank?

- 1 = First year student
- 2 = Sophomore
- 3 = Junior
- 4 = Senior
- 5 = Graduate student
- 6 = Other

3. What is your sex?

- 1 = Male
- 2 = Female

4. What is your current GPA?

- 1 = Less than 2.0
- 2 = 2.00 – 2.49
- 3 = 2.50 – 2.99
- 4 = 3.00 – 3.49
- 5 = 3.50 – 4.00
- 6 = No GPA earned yet

5. How would you rate your experience with computers?

- 1 = Novice
- 2 = Below Average
- 3 = Average
- 4 = Proficient
- 5 = Expert

6. In how many courses that you have taken did you use the Classroom Performance System (CPS)?

- 1 = 1 course
- 2 = 2 courses
- 3 = 3 courses
- 4 = 4 courses
- 5 = 5 courses
- 6 = No courses (zero)

PART II.

INSTRUCTIONS: The following questions ask about your attitudes and routines you plan to engage in during this class. Remember there are no right or wrong answers; just answer as accurately as possible. Use the scale underneath each question to identify your answer. If you think the statement is very true of you, darken in the circle on the scan sheet that corresponds to that number; if a statement is not at all true of you, darken in the circle on the scan sheet of that number. If the statement is more or less true of you, darken in the circle on the scan sheet of the number between “very true” and “not at all true” that best describes you.

1 = not at all true of me 2 3 4 5 6 7 = very true of me

7. If course readings are difficult to understand, I plan to change the way I read the material.

1 = not at all true of me 2 3 4 5 6 7 = very true of me

8. I believe I will receive an excellent grade in this class.

1 = not at all true of me 2 3 4 5 6 7 = very true of me

9. When I study for this class, I plan to set goals for myself in order to direct my activities in each study period.

1 = not at all true of me 2 3 4 5 6 7 = very true of me

10. I'm confident I can understand the most complex material presented by the instructor in this course.

1 = not at all true of me 2 3 4 5 6 7 = very true of me

11. I plan to try to think through a topic and decide what I am supposed to learn from it rather than just reading it over when studying for this course.

1 = not at all true of me 2 3 4 5 6 7 = very true of me

12. I expect to do well in this class.

1 = not at all true of me 2 3 4 5 6 7 = very true of me

13. I plan to try to change the way I study in order to fit the course requirements and the instructor's teaching style.

1 = not at all true of me 2 3 4 5 6 7 = very true of me

14. During class time I think I will often miss important points because I'm thinking of other things.

1 = not at all true of me 2 3 4 5 6 7 = very true of me

15. I'm certain I can master the skills being taught in this class.

1 = not at all true of me 2 3 4 5 6 7 = very true of me

16. When I become confused about something I'm reading for this class, I plan to go back and try to figure it out.

1 = not at all true of me 2 3 4 5 6 7 = very true of me

17. Before I study new course material thoroughly, I plan to often skim it to see how it is organized.

1 = not at all true of me 2 3 4 5 6 7 = very true of me

18. Considering the difficulty of this course, the teacher, and my skills, I think I will do well in this class.

1 = not at all true of me 2 3 4 5 6 7 = very true of me

19. I plan to ask myself questions to make sure I understand the material I have been studying in this class.

1 = not at all true of me 2 3 4 5 6 7 = very true of me

20. I'm confident I can do an excellent job on the assignments and tests in this course.

1 = not at all true of me 2 3 4 5 6 7 = very true of me

21. I think that I will often find that I have been reading for this class but don't know what it was all about.

1 = not at all true of me 2 3 4 5 6 7 = very true of me

22. I'm confident I can learn the basic concepts taught in this course.

1 = not at all true of me 2 3 4 5 6 7 = very true of me

23. When studying for this course, I plan to try to determine which concepts I don't understand well.

1 = not at all true of me 2 3 4 5 6 7 = very true of me

24. I'm certain I can understand the most difficult material presented in the readings for this course.

1 = not at all true of me 2 3 4 5 6 7 = very true of me

25. When reading for this course, I plan to make up questions to help focus my reading.

1 = not at all true of me 2 3 4 5 6 7 = very true of me

26. If I get confused taking notes in class, I plan to make sure I sort it out afterwards.

1 = not at all true of me 2 3 4 5 6 7 = very true of me

27. I'm confident I can learn how to use the Classroom Performance System.

1 = not at all true of me 2 3 4 5 6 7 = very true of me

Appendix C Post-Course Survey

INSTRUCTIONS: In the IDENTIFICATION section of the scan sheet write in your ID. Then darken in the letters and numbers in each column that correspond to the letters and numbers of your ID. This information will be used to match your survey results to other information you provide throughout the semester. Once all the information has been collected, all personally identifying information will be removed and will in no way be used or released.

PART I.

INSTRUCTIONS: The following questions ask about your attitudes and routines you engaged in during this class. Remember there are no right or wrong answers; just answer as accurately as possible. Use the scale underneath each question to identify your answer. If you think the statement is very true of you, darken in the circle on the scan sheet that corresponds to that number; if a statement is not at all true of you, darken in the circle on the scan sheet of that number. If the statement is more or less true of you, darken in the circle on the scan sheet of the number between “very true” and “not at all true” that best describes you.

1 = not at all true of me 2 3 4 5 6 7 = very true of me

1. If course readings were difficult to understand, I changed the way I read the material.

1 = not at all true of me 2 3 4 5 6 7 = very true of me

2. I believed I would receive an excellent grade in this class.

1 = not at all true of me 2 3 4 5 6 7 = very true of me

3. When I studied for this class, I set goals for myself in order to direct my activities in each study period.

1 = not at all true of me 2 3 4 5 6 7 = very true of me

4. I was confident I could understand the most complex material presented by the instructor in this course.

1 = not at all true of me 2 3 4 5 6 7 = very true of me

5. I thought through a topic and decided what I was supposed to learn from it rather than just reading it over when I studied for this course.

1 = not at all true of me 2 3 4 5 6 7 = very true of me

6. I expected to do well in this class.

1 = not at all true of me 2 3 4 5 6 7 = very true of me

7. I changed the way I studied in order to fit the course requirements and the instructor's teaching style.

1 = not at all true of me 2 3 4 5 6 7 = very true of me

8. During class time I often missed important points because I was thinking of other things.

1 = not at all true of me 2 3 4 5 6 7 = very true of me

9. I was certain I could master the skills being taught in this class.

1 = not at all true of me 2 3 4 5 6 7 = very true of me

10. When I became confused about something I was reading for this class, I went back and tried to figure it out.

1 = not at all true of me 2 3 4 5 6 7 = very true of me

11. Before I studied new course material thoroughly, I often skimmed it to see how it was organized.

1 = not at all true of me 2 3 4 5 6 7 = very true of me

12. Considering the difficulty of this course, the teacher, and my skills, I think I did well in this class.

1 = not at all true of me 2 3 4 5 6 7 = very true of me

13. I asked myself questions to make sure I understood the material I studied in this class.

1 = not at all true of me 2 3 4 5 6 7 = very true of me

14. I was confident I could do an excellent job on the assignments and tests in this course.

1 = not at all true of me 2 3 4 5 6 7 = very true of me

15. I often found that I was reading for this class but didn't know what it was all about.

1 = not at all true of me 2 3 4 5 6 7 = very true of me

16. I was confident I could learn the basic concepts taught in this course.

1 = not at all true of me 2 3 4 5 6 7 = very true of me

17. When studying for this course, I tried to determine which concepts I didn't understand well.

1 = not at all true of me 2 3 4 5 6 7 = very true of me

18. I was certain I could understand the most difficult material presented in the readings for this course.

1 = not at all true of me 2 3 4 5 6 7 = very true of me

19. When reading for this course, I made up questions to help focus my reading.

1 = not at all true of me 2 3 4 5 6 7 = very true of me

20. If I got confused taking notes in class, I made sure I sorted it out afterwards.

1 = not at all true of me 2 3 4 5 6 7 = very true of me

21. I was confident I could learn how to use the Classroom Performance System.

1 = not at all true of me 2 3 4 5 6 7 = very true of me

PART II.

INSTRUCTIONS: The following questions ask about your perceptions of the course and the Classroom Performance System. Use the scale underneath each question to identify your answer. If you strongly disagree with the statement, darken in the circle on the scan sheet of that number. If you strongly agree with the statement, darken in the circle on the scan sheet that corresponds to that number. If your level of agreement falls somewhere in between, darken in the circle on the scan sheet of the number between that best describes your opinion.

1 = Strongly disagree (SD)

2 = Disagree (D)

3 = Neutral/no opinion (N)

4 = Agree (A)

5 = Strongly Agree (SA)

The following questions ask you about your experiences in lecture classes (Monday/Wednesday meetings).

22. The *lecture sessions* were helpful to my learning of the course content.

1 (SD) 2 (D) 3 (N) 4 (A) 5 (SA)

23. The questions asked with the CPS *during lecture sessions* helped prepare me for the exams.

1 (SD) 2 (D) 3 (N) 4 (A) 5 (SA)

24. The questions asked with the CPS *during lecture sessions* helped me learn better.

1 (SD) 2 (D) 3 (N) 4 (A) 5 (SA)

25. The CPS was an integral part of the *lecture sessions*.

1 (SD) 2 (D) 3 (N) 4 (A) 5 (SA)

26. The CPS helped me realize how much I understood about what was being covered in the *lecture sessions*.

1 (SD) 2 (D) 3 (N) 4 (A) 5 (SA)

27. The CPS helped me realize how I compared to my classmates' performance *in lecture sessions*.

1 (SD) 2 (D) 3 (N) 4 (A) 5 (SA)

28. Using the CPS system caused me to change how I prepared for *lecture classes*.

1 (SD) 2 (D) 3 (N) 4 (A) 5 (SA)

29. Using the CPS increased my confidence in my own understanding of the material covered in *lecture sessions*.

1 (SD) 2 (D) 3 (N) 4 (A) 5 (SA)

30. The CPS was easy to use *in lecture sessions*.

1 (SD) 2 (D) 3 (N) 4 (A) 5 (SA)

The following questions ask you about your experiences in discussion classes (Thursday meetings).

31. The *discussion sessions* were helpful to my learning of the course content.

1 (SD) 2 (D) 3 (N) 4 (A) 5 (SA)

32. The questions asked with the CPS *during discussion sessions* helped prepare me for the exams.

1 (SD) 2 (D) 3 (N) 4 (A) 5 (SA)

33. The questions asked with the CPS *during discussion sessions* helped me learn better.

1 (SD) 2 (D) 3 (N) 4 (A) 5 (SA)

34. The CPS was an integral part of the *discussion sessions*.

1 (SD) 2 (D) 3 (N) 4 (A) 5 (SA)

35. The CPS helped me recognize how much I understood about what was being covered in the *discussion sessions*.

1 (SD) 2 (D) 3 (N) 4 (A) 5 (SA)

36. The CPS helped me realize how I compared to my classmates' performance *in discussion sessions*.

1 (SD) 2 (D) 3 (N) 4 (A) 5 (SA)

37. The CPS system caused me to change how I prepared for *discussion classes*.

1 (SD) 2 (D) 3 (N) 4 (A) 5 (SA)

38. Using the CPS increased my confidence in my own understanding of the material covered in *discussion sessions*.

1 (SD) 2 (D) 3 (N) 4 (A) 5 (SA)

39. The CPS was easy to use in the *discussion sessions*.

1 (SD) 2 (D) 3 (N) 4 (A) 5 (SA)

Appendix D Rating Scales

Beginning of Class

How confident do you feel about your understanding of the content in the assigned reading for today?

- A = Not at all confident
- B = A little confident
- C = Somewhat confident
- D = Very confident
- E = Extremely confident

End of Class

At the beginning of the class period you rated your confidence in the material being taught today. Now that you have completed the review questions, how accurate were your predictions?

- A = Not at all accurate
- B = A little accurate
- C = Somewhat accurate
- D = Very accurate
- E = Extremely accurate

Appendix E
Student Focus Group Protocol

Wednesday, August 4, 2004
12:30-2:00 p.m.

Formal Introductions:

- ***Introduce staff:*** Facilitator and assistant
- ***Explain purpose:*** The division is conducting a study on the Classroom Performance System (CPS) to understand how to best use the technology. The purpose of today's discussion is to get feedback about your experiences with the system in your computer science class. I'll begin with some basic questions, but please feel free to contribute any information you think might be helpful.
- ***Participant introductions:*** Have each participant introduce self and tell year/major/hometown.

Questions:

1. What do you *like* about using the Classroom Performance System (CPS)?
2. What do you *dislike* about using CPS?
3. In what ways does using CPS *help you learn* in this course?
 - a. What *specifically* did it help you learn?
 - b. Did the CPS *affect how you prepared* for class? *Describe*.
 - c. How did *seeing your classmates' responses* to the questions influence how you learned or studied?
4. *What did NOT work* so well with the CPS? Were there *problems*?
 - a. How could it be improved?
 - b. Were there any *technical problems* related to using CPS?
 - i. Were the technical problems *resolved during class*?
 - ii. Did the technical problems *interfere with your learning*?
5. Was there a difference in how CPS was used in *lecture versus discussion* classes? *Explain*.
 - a. Did one method help you *learn better* than the other?
6. Do you *prefer* answering review questions *using CPS or paper*? *Explain*.
7. Have you used CPS in any *other courses*?
 - a. *How was it used* in those courses?
 - b. How was it *different / similar* to CS 303W?
 - c. Would you like to see *CPS used in more of your courses*? *Explain*.
8. *What could instructors do to make your experience with CPS better*?

Do any of you have any questions about CPS, this focus group, or the study?

Appendix F

Analysis of Minute Papers

June 21, 2004: 37 minute papers

Thirteen students commented on how the lecture clarified the confusions they had before class. The general feeling among these students was that the pace of the lecture was very good, if not too slow. However, ten other students did not feel confident about the lecture and/or the material after the lecture. A few of these students felt that the pace of the lecture was too fast for them to keep up. Also, some of these students left the class with questions on how the lecture material applied to computer science.

June 23, 2004: 39 minute papers

Twelve students commented generally that they had high confidence about the material, enjoyed using the CPS, and/or that the pace of the lecture was good. However, one of these students did not have a pleasurable experience with using the CPS. Seven other students reported that they were still confused on certain concepts, some attributing their confusion to the fast pace of the lecture.

June 28, 2004: 37 minute papers

Thirteen students indicated that they were completely lost and/or were worrying about the upcoming test. Some of these students felt that they weren't given enough exposure to the kinds of things that they assumed would be on the test. Also, some of these students indicated that they needed immediate help, providing an e-mail address for setting up an appointment with the instructor. An additional student expressed his/her frustration with how new concepts were being introduced without first being taught how to apply them. Still another student asked a basic clarification question concerning the material of the lecture.

July 5, 2004: 31 minute papers

Eight students expressed the general impression that this lecture gave them more confidence in the material; their confusions had been cleared up. Three other students expressed

concern that they were not getting enough practice in programming. Another three students indicated that they were still somewhat confused about some of the concepts from the lecture. One student requested that the “evaluation questions” be posted on the website.

July 7, 2004: 35 minute papers

Fourteen students indicated that they were still confused about some concepts after the lecture. A few of these did acknowledge that their confusion might be cleared up with a little practice. However, the rest did not appear to have that optimism, including one student who felt that he/she did not have the slightest idea what was taught in the lecture.

July 12, 2004: 36 minute papers

Five students reported some confusion remaining after the lecture. One of these students expressed confusion over the homework assignment. Three other students stated that the confusion they had before class had now been cleared up through the lecture. Another student requested that the CPS questions be posted online with their explanations, because the in-class explanations went too quickly.

July 14, 2004: 34 minute papers

Thirteen students indicated that they were still confused about concepts after this lecture. A few of these students posed application questions that they were unsure about; others had confusion about the overall goal and logic of the concepts. Two other students expressed that the lecture helped clear up the confusions they had before class.

July 21, 2004: 31 minute papers

Twenty students made small suggestions that they felt would have made the exam in question more suitable for the class. Most frequently suggested were having more time, having more practice, and receiving preparation for what may be asked. On the other hand, eight students felt that the test was what it should have been, regardless of how difficult or time-consuming they thought it was. These students reflected on advice that they should have taken in

preparing for the exam. Still, two other students seemed not to agree with the test's format, difficulty, point structure, and/or length.

July 26, 2004: 29 minute papers

Three students asked questions about how the concepts in this picture related to the overall goals of computer science, how these concepts relate to a computer program. Two other students commented on how the lecture made the material much clearer, while one other student indicated that the classes were getting harder.

July 28, 2004: 27 minute papers

Four students expressed how the lecture cleared up their confusion about various concepts. One student posed an application question on material from the lecture. Six other students indicated that they were confused about some concepts, mostly indicating specific sources of confusion.

August 2, 2004: 27 minute papers

Three students indicated that the material was clear, but that they could use some practice to reinforce some of the concepts. Eight other students reported that they were still confused about this material, and some of these reported confusion about previous material. One other student commented on how the current material was "not fun."

August 4, 2004: 27 minute papers

Seven students indicated degrees of confusion ranging from needing slight clarifications to not knowing what questions to ask. Two other students posed application questions that appear to be asked for clarification purposes. Two other students asked administrative questions concerning material on the upcoming exam.

August 9, 2004: 15 minute papers

Four students indicated confusion about the material after the lecture. One of these students indicated that the confusion was on implementation of the concept. Two other students commented on how the lecture made the concept much clearer to them, compared to just reading the text alone.