A CASE FOR SMALLER CLASS SIZE WITH INTEGRATED LAB FOR INTRODUCTORY COMPUTER SCIENCE

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Introduction

Interest

- Traditionally, CS1 at NCSU has been offered in large sections (>150) with separate, smaller, TA supervised labs (~ 30)
- Over the past few years NCSU have seen a decline in ‘CS major’ enrolment as well as reduced retention in underrepresented groups
- In order to identify potential causes, NCSU decided to modify its CS1 course offering

Evidence

- Bloom's foundational study established the superiority of one-on-one tutoring, but Group instruction is more feasible and less resource heavy
- Limiting class size makes active learning (for example through integrated labs) a viable approach
- Active learning encourages 'deep learning' and empirical evidence suggests that it enhances student performance in CS1 and increases student retention (lower CS2 dropout rates)

Research

- Semester long pilot study over Spring 2006
- 2 additional sections were offered, with smaller class sizes (~30 students) and integrated labs

Hypotheses

- Attitude: Students in small sections display a more positive attitude towards CS
- Learning: Student learning is improved for students in small classes
- Retention: Student retention is better in small sections
- Underrepresented Groups: Improvements are noticeable for these groups especially

All statements are relative to students in large sections

Design

Class Composition

- 3 large sections (control), 2 small section (experimental)
- CS majors were given priority to enroll in the small sections

Table 1: Respondent Major by Class Size

	Computer Science	Other Majors	
Large Classes	20 (11%)	166 (89%)	186
Small Classes	37 (73%)	14 (27%)	51
	57	180	237

Table 2: Respondent Gender by Class Size

	Females	Males	
Large Classes	20 (10%)	173 (90%)	193
Small Classes	4 (8%)	49 (92%)	53
	24	222	246

Table 3: Respondent Race by Class Size

	White	African Amer-ican	Asian	Hisp-anic	Other	
Large Classes	148 (80%)	16 (9%)	15 (8%)	4 (2%)	3 (1%)	186
Small Classes	38 (74%)	6 (12%)	6 (12%)	1 (2%)	0 (0%)	51
	186	22	21	5	3	237

Instructors

- 2 instructors each for small and large sections, they all share a set of common learning outcomes
- Both small sections had similar process of presenting course material
  concept -> example -> lab
- Both large section instructors felt detachment and had trouble maintaining engagement
- All instructors assigned the same programming projects, no significant difference found in scores between any pair of sections

Data Sources

- Online Surveys: 60 item survey of declarative statements, students rate their agreement on a 5-value Likert scale

  Response rate was 86% for small sections and 46% for large sections, 237 in total
- Student Grades: performance data from all students who finished the course (467)
- Standard Exam Questions placed in all midterms and finals; instructors did not have access to these questions beforehand
- Student Data: High School GPA, NCSU GPA, SAT scores, gender, ethnicity
- Instructor Interviews: to identify and log differences in teaching style

Results

Student Attitude

- Paired t-test to identify change in attitude based on change in pre and post survey responses
- Chi-Square test for independence to identify significant difference in survey responses between treatment groups
- Class Environment: students in small sections are more comfortable asking questions and students in large sections find it difficult to “remain focused, stay on task, and follow the lesson as easily as students in small sections”

Learning

- No statistical difference between treatment groups w.r.t prior GPA and SAT scores
- 2-sample t-test reveals students in small sections scored better on standard exam questions, averaging 79%, whereas the large sections averaged 62%
- 83% of students in the large sections who completed the course were passing, 94% for the small sections
- Non-majors in large sections have an 83% passing rate, and in small sections have an 86% passing rate
- Majors in large sections have a 90% passing rate, and in small sections have a 97% passing rate

Retention

- Percentage of enrolled students who remain enrolled throughout the semester
- Small sections have retention rates of 87% and 97%
- The large sections have retention rates between 66% and 75%
- One semester after the study, 87% of CS majors from small sections were still majoring CS; 75% for the large sections
- For underrepresented groups, 100% of small section CS majors have remained in the program, 83% for the large section CS majors

Conclusion

- All hypotheses were validated
- Retention rates across the semester were around 20% higher in small sections
- “Small classes with integrated labs hold many benefits for students over large classes with separate labs”

Critique

- Student Attitude results could have been better presented in the form of a table of significant survey questions and categorical mean responses
- The experiment puts two changes into effect simultaneously, results might be different if only one of the changes is implemented. Was the active learning more impactful, or was it the reduced class size?