

Partnership Characteristics and Student Performance in an Introductory Computer Science Course

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**ELECTRICAL ENGINEERING
AND COMPUTER SCIENCE**
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Outline

- Introduction and related work
- Data set and methods
- Results
- Limitations and conclusions

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Pair Programming

- A software development technique
- Two programmers + one workstation
- How it is supposed to work:
 - “Driver” controls mouse and keyboard
 - “Navigator” observes and offers solutions to problems
 - Programmers switch roles frequently
- What is NOT supposed to happen:
 - Divide-and-conquer
 - Driver does all of the work

Pair Programming – Prior Work

- Higher project scores in an introductory computer science course
 - McDowell et al.
- Better performance on individual work and exams
 - Mendes et al.

Pair Programming

- Last year at ASEE:
- Better project performance, especially in lowest GPA quartile
 - CS2 optional partnerships
 - CS3 all individual work
 - Giugliano et al.
- Compared students who chose to partner with those who chose to work alone
- In this paper, we look to combine performance data of previous work with partnership compatibility

Partnership Compatibility

- Students desire compatible partnerships
 - Nagappan et al.
- Mixed-gender partnerships less likely to report compatibility than same-gender
 - Katira et al.
- Differences in personalities did not contribute to academic performance of partnership
 - Personalities measured using the five factor model
 - Salleh et al. (2009) and Hannay et al. (2010)

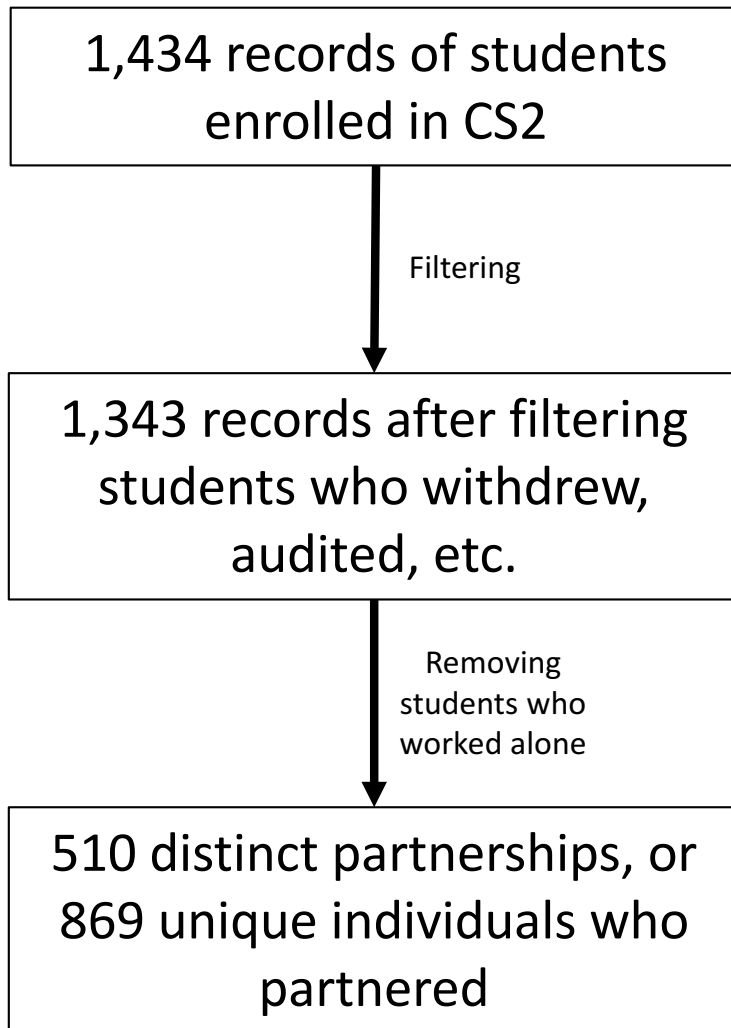
Research Questions

- What kinds of partnerships form? Are these partnerships balanced?
- Do balanced partnerships perform better or worse than unbalanced ones?
- Does starting projects early affect performance?

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Data Set



- Large research university
- Data set included:
 - Two semesters of CS2 data
 - Project scores
 - Exam scores
 - Partner status for each project in CS2
 - Date and time of project submissions
 - Gender
 - Cumulative GPA
 - Partnerships only

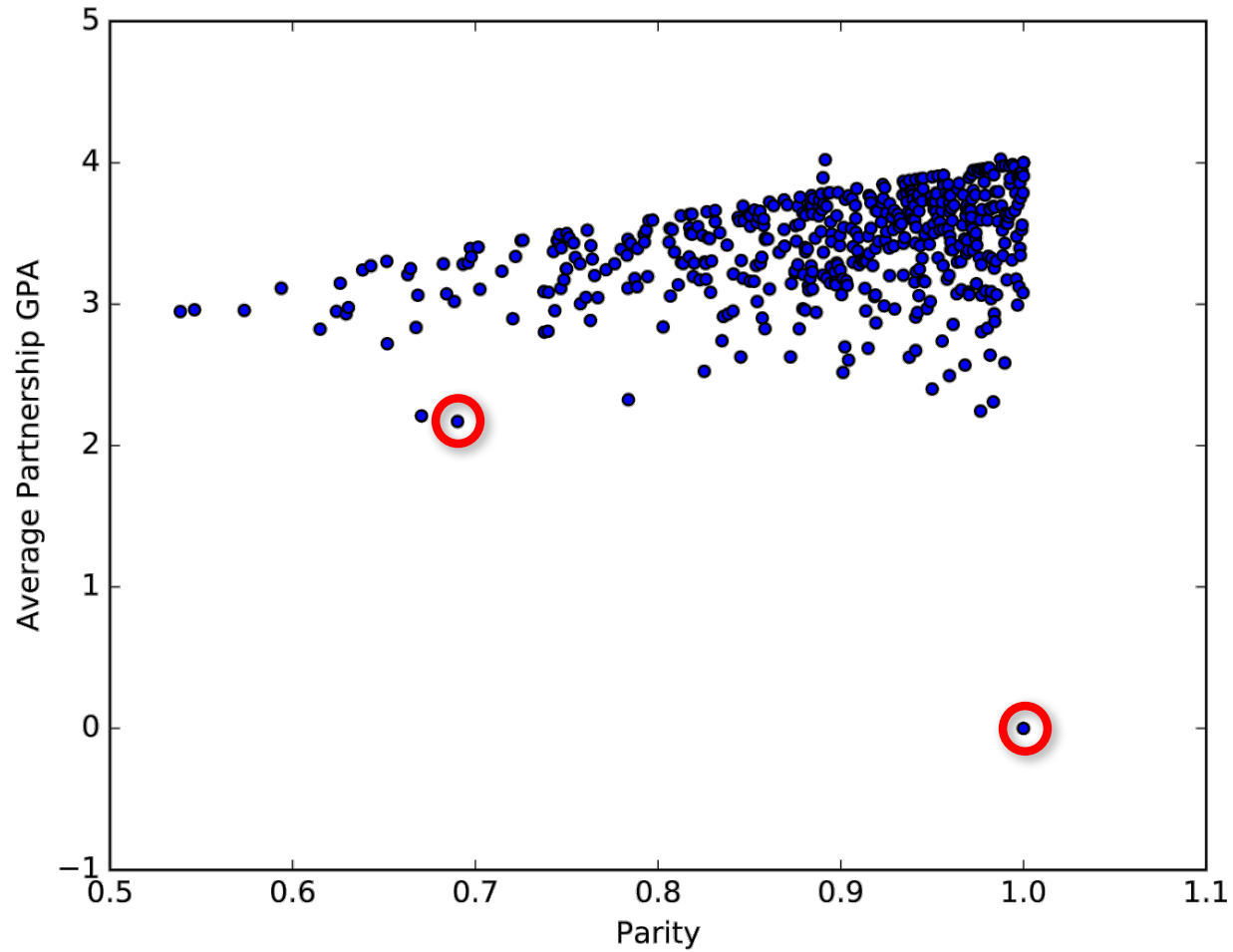
Partnership Metrics

- Parity:
 - Difference in partners' GPAs normalized to a [0,1] scale
 - Calculated as: $P = \frac{4.0 - |(GPA_0 - GPA_1)|}{4.0}$
 - P=0 implies opposite GPAs
 - P=1 implies identical GPAs
- Gender makeup:
 - Two men, two women, mixed gender
- Work habits or early-start:
 - How early a partnership started a project
 - Calculated as: $\frac{1}{n} \sum_1^n z_i$ where:
 - n: number of projects that partners worked together on
 - z_i : number of days early partnership first submitted the i-th project they worked together on, represented as a z-score
- Independent variables

Performance Metrics

- Project performance:
 - Average grade of all projects completed by partnership
- Exam performance:
 - Average of two partners' exam grades
- Course performance:
 - Average of two partners' course letter grade
 - Converted letter grade to number on 4.0 scale
- Dependent variables

Partnership GPA vs. Parity



Descriptive Statistics

Gender Composition	Count	Average GPA	Average Partnership GPA Parity	Average “Early-start on Projects” Z-score
Two Women	62	3.398	0.886	-0.031
Two Men	319	3.419	0.890	-0.010
Mixed Gender	129	3.416	0.904	0.033
All Individuals	510*	3.415	0.893	-0.002

*Note: One partnership was removed, as it was an outlier.
This did not affect the trends we saw in our results.

Statistical Methods

- Z-scores for grade data
 - Data was collected over different semesters
- Z-scores for work habits metric
 - Each project had a different time frame
- Calculated per-semester, per-assignment
- Used multivariate ANOVA to evaluate statistical significance of observations

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Results – Parity

- No significant association with project grade after considering average GPA
- No significant association with exam grade after considering average GPA

	Average Exam Score				Average Project Score			
	SS	df	F	p	SS	df	F	p
Parity	0.01	1	0.03	0.871	0.72	1	2.72	0.100
Average GPA	61.51	1	242.99	0.000	30.61	1	115.84	0.000
Parity:GPA	0.16	1	0.65	0.422	0.77	1	2.92	0.088

Results – Work Habits

- Correlation with exam scores and project scores were statistically significant
- Significant, even after considering average GPA

	Average Exam Score				Average Project Score			
	SS	df	F	p	SS	df	F	p
Work Habits	2.20	1	8.70	0.003	2.91	1	11.00	0.001
Average GPA	61.51	1	242.99	0.000	30.61	1	115.84	0.000
Work Habits:GPA	0.04	1	0.15	0.698	0.04	1	0.13	0.715

Results – Work Habits

- Mean course grades higher for students who started projects earlier
 - Most significant change for students in lowest GPA quartiles

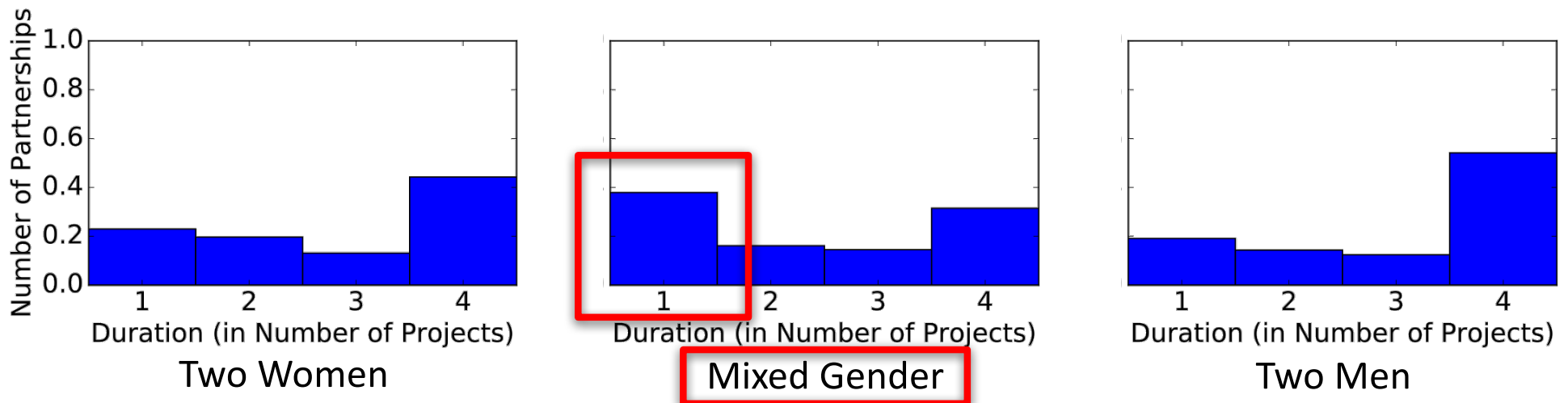
	Work Habits Q1	Work Habits Q2	Work Habits Q3	Work Habits Q4
GPA Q1	C+ (2.3)	C+ (2.4)	C+/B- (2.6)	B- (2.7)
GPA Q2	B- (2.8)	B (3.0)	B (3.0)	B+ (3.2)
GPA Q3	B+ (3.2)	B+ (3.3)	B+ (3.3)	B+/A- (3.5)
GPA Q4	B+/A- (3.6)	A- (3.7)	A- (3.7)	A- (3.7)

Results – Work Habits

- Results might imply that partnerships who start projects earlier learn material better
- However, variance explained by starting early is small compared to average GPA

Results – Gender Makeup

- No association between project scores and gender makeup
- Association between exam scores and gender makeup was significant
 - Specifically, two men tended to perform slightly better
 - In the future, would like to look into this further
- Mixed gender partnerships tended to have shorter durations



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Limitations

- Students chose whether to partner
- Students chose with whom to partner
- Class standing could affect parity metric
- No information or control on group dynamics
- Data set from multiple semester offerings of course

Conclusions

- Partnership parity was not associated with project or exam performance
- Starting projects early had a positive association with project and exam performance
- Students with below-median GPAs were associated with the greatest improvements from starting early
 - Lowest early-start quartile averaged a C+ in the course
 - Highest early-start quartile averaged a B- in the course
- Duration of partnerships was associated with gender composition
 - Same gender partnerships tended to last the entire semester
 - Mixed gender partnerships tended to span only one project or the entire semester