USING HP HAND-HELD COMPUTERS IN OUR CLASSROOMS*

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Impact on Learning

We have examined the impact on student learning of using the HP PDAs as a classroom interaction system and the reformed pedagogical practices that were facilitated by this technology.

Research Questions

The following two research questions were framed to examine the impact of this technology and reformed pedagogy on student learning:

> Research Question 1: Did student learning, as measured by similar course assessments (exams, homework etc.) improve relative to before the project was implemented?

> Research Question 2: Did students who used the technology as intended in class more frequently perform better than those who used the technology less frequently, and vice versa?

Methodology

We used quantitative methods to address the aforementioned research questions. The following sources of data were used:

o Student course grades *before* the HP PDAs were implemented in the classroom (N = 64)
o Student course grades *after* the HP PDAs were implemented in the classroom (N= 87)
o Student data logs as they responded to questions posed by the instructor using the PDA-based classroom interaction system (N=87)

Data Analysis

Comparing Students <u>Mean Course GPA</u> *Before* PDAs with *After* PDAs

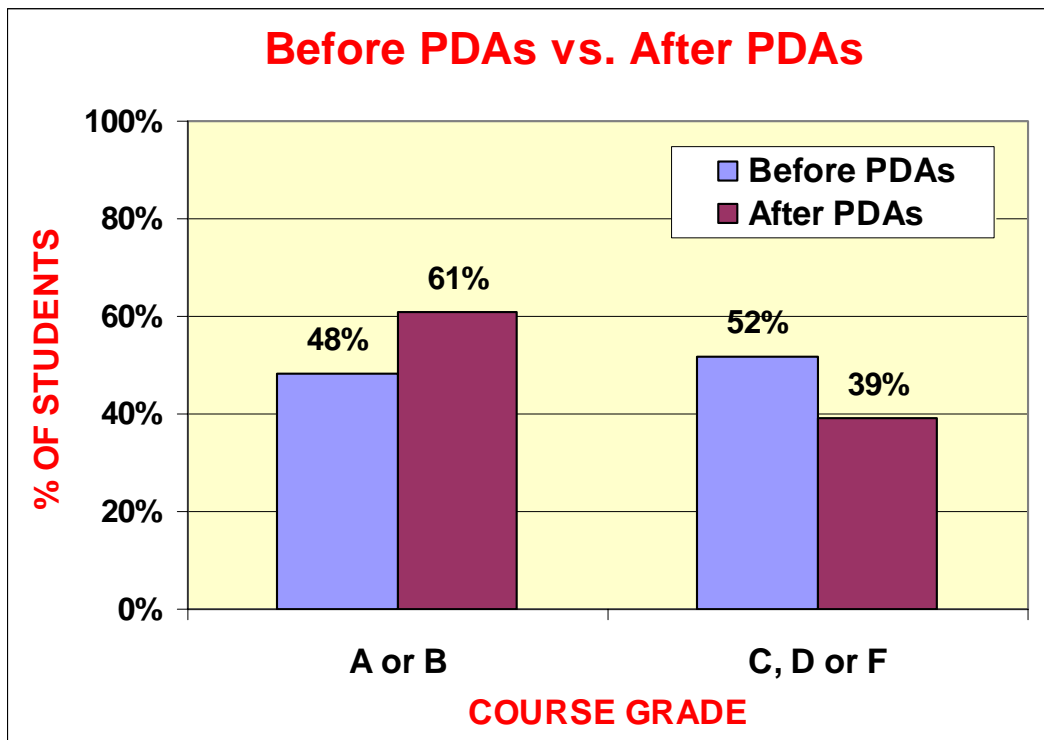Statistically significant difference between <u>Mean Course GPA</u>

T-test (one-tailed) shows $p < 0.03$

t-**Test: Two-Sample Assuming Unequal Variances**

	Before PDAs	After PDAs
Mean	2.3125	2.609195402
Variance	0.884920635	1.147821438
Observations	64	87
Hypothesized Mean Difference	0	
df	144	
t Stat	1.804954495	
P(T<=t) one-tail	0.036585597	
t Critical one-tail	1.655503183	
P(T<=t) two-tail	0.073171195	
t Critical two-tail	1.976577551	

Comparing Student <u>Course Grades</u> *Before* PDAs with *After* PDAs

Significant difference in course grade distribution
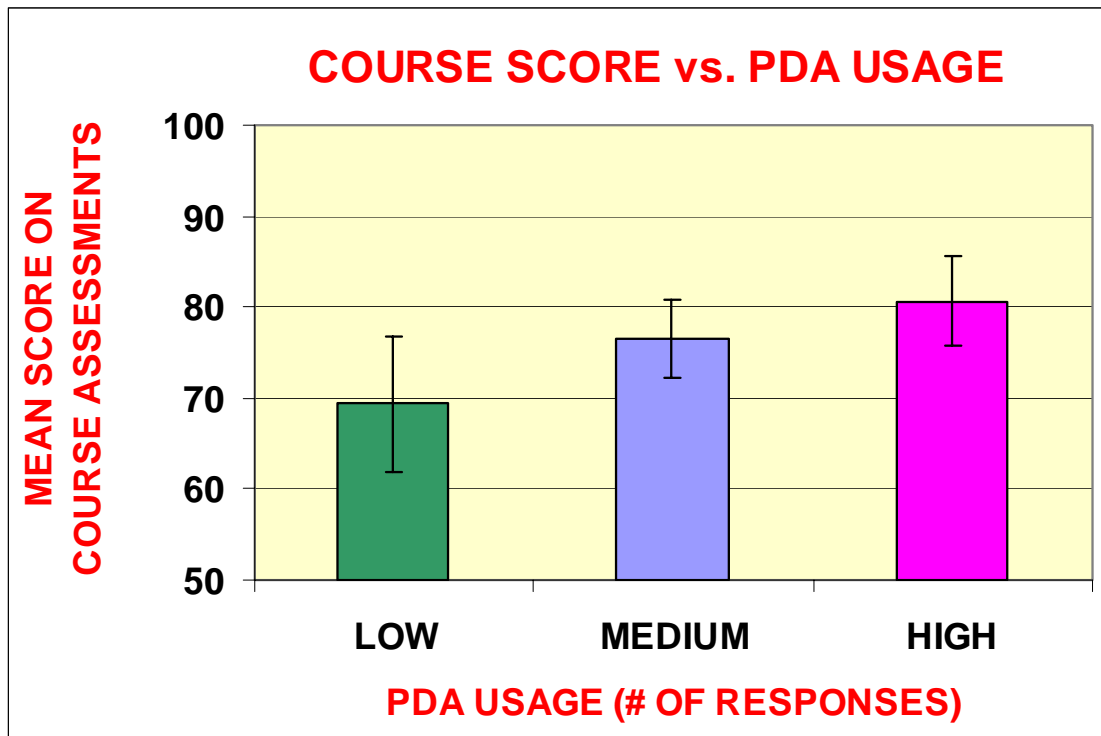
Comparing Mean Course Scores vs. PDA Usage in Class

ANOVA (single factor analysis) shows a statistically significant difference between mean course scores for **LOW**, **MEDIUM** and **HIGH** users[1] of the PDAs in the classroom based on their responses on the classroom interaction system.

P-value = 0.015 for F= 4.408 with $F_{critical}$ = 3.105

ANOVA: Single Factor

SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
LOW	6	416.04	69.34	218.667		
MEDIUM	19	1451.72	76.40632	73.42905		
HIGH	62	5001.98	80.6771	95.0374		

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	861.9727	2	430.9864	4.408349	0.015116	3.105157
Within Groups	8212.339	84	97.76594			
Total	9074.312	86				

COURSE SCORE vs. PDA USAGE

(Bar chart: MEAN SCORE ON COURSE ASSESSMENTS vs. PDA USAGE (# OF RESPONSES) for LOW, MEDIUM, HIGH groups with error bars.)

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[1] LOW users responded to less than 33% of the questions posed on the classroom responses system.
MEDIUM users responded to between 34% and 66% of the questions posed on the classroom response system.
HIGH users responded to 67% or more of the questions posed on the classroom response system.

Comparing PDA Usage vs. Grade bands

ANOVA (single factor analysis) shows a statistically significant difference between students in different grade bands of the course.

P-value = 0.030 for F= 3.119 with $F_{critical}$ = 2.715

ANOVA: Single Factor

SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
A	18	2739	152.1667	1236.147		
B	35	4837	138.2	1583.282		
C	19	2249	118.3684	1802.023		
D or F	15	1726	115.0667	2755.638		

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	16445.95	3	5481.983	3.11943	0.030374	2.714565
Within Groups	145861.5	83	1757.367			
Total	162307.4	86				

PDA USAGE vs. COURSE GRADE
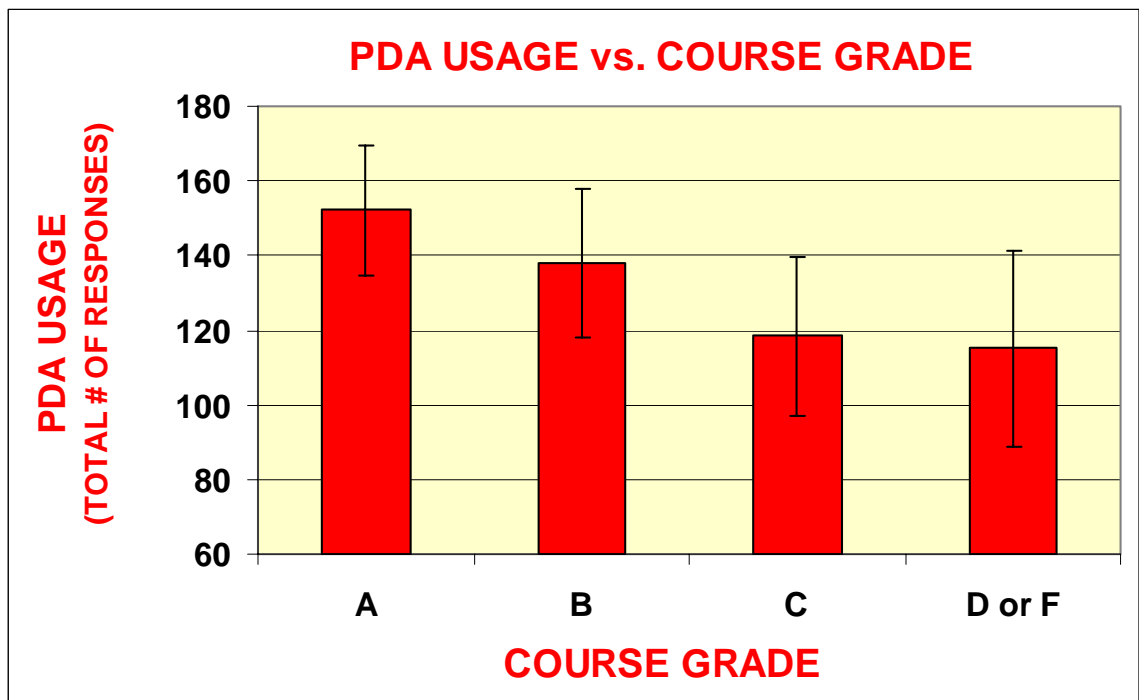
Correlation between Overall Course Score and PDA Usage in Class

A weak, though statistically significant correlation was found between overall course score and PDA usage in class.

Pearson Correlation Coefficient = 0.372
at F = 13.714 with $F_{significance}$ = 0.00037

Regression Statistics

Multiple R	0.372734346
R Square	0.138930893
Adjusted R Square	0.128800668
Standard Error	9.587743259
Observations	87

ANOVA

	df	SS	MS	F	Significance F
Regression	1	1260.702276	1260.702	13.71449	0.000377
Residual	85	7813.609768	91.92482		
Total	86	9074.312044			
	Coefficients	Standard Error	t Stat	P-value	
Intercept	67.26113922	3.322708234	20.24287	2.91E-34	
PDA USAGE	0.088132706	0.023798371	3.703308	0.000377	

OVERALL COURSE SCORE vs. PDA USAGE
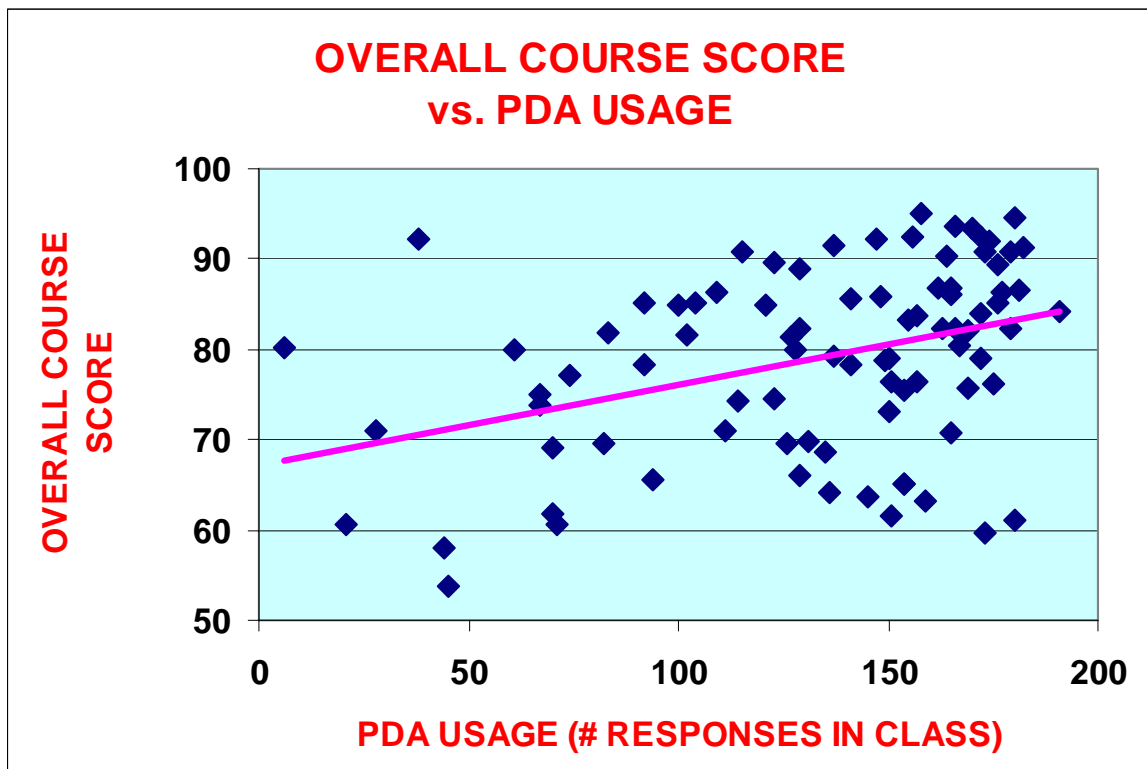
Results & Discussion

Overall, our data analysis above shows evidence of the following:

- o There is a statistically significant improvement in overall course grades after the PDA-based system was implemented. Before the PDA-based classroom interaction system was implemented about one half of the students secured an A or a B in class. The following year, when the system was implemented nearly two-thirds of the students secured an A or a B in the class. Both of these courses in successive years were taught by the same instructor, covering the same content and using very similar, and partly identical course assessments. The student population in these two courses was also statistically similar in terms of their SAT scores etc.
- o In the class in which the PDA-based system was implemented, students who used the system more frequently in class performed statistically significantly better in terms of their mean score on the course assessments. Conversely, there was also a statistically significant difference between students getting an A, B, C, or D/F in terms of their usage of the PDA-based system in class. Students who secured an A were used the system much more often than students who got a D or F. This indicates that students who used the system in class more frequently are likely to get higher grades and also that those who secure higher grades used the system in class more frequently.
- o Consistent with the result described above, a weak but statistically significant correlation was observed between PDA usage in the classroom and students' mean performance score on course assessments. Correlation does *not* imply causality, so these results do *not* imply that students' grades will improve merely by making them use the PDA-based classroom response system.

Conclusions

We sought to address the following research questions in this study:

<u>Research Question 1</u>: Did student learning, as measured by similar course assessments (exams, homework etc.) improve relative to before the project was implemented?

Yes, we did find a statistically significant improvement in course performance between the semester in which we had not used the PDA-based system and the one in which we did use the system for similar students and identical content and instruction.

<u>Research Question 2</u>: Did students who used the technology as intended in class more frequently perform better than those who used the technology less frequently, and vice versa?

Yes, we did find that more frequent users secured higher course grades and conversely that students who secured higher course grades performed had used the system more frequently in the class.