OPEN POLICY FOR WIRELESS COMPUTERS IN CLASROOMS: WHAT MAKES IT A GOOD OR A BAD IDEA?

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ABSTRACT

Increasingly, studies and media articles have been looking into possible adverse effects of open policies for using wireless ready computers in classrooms. Tablet PCs, as indicated by some of those authors, are under suspicion more than laptops because they make it harder for instructor to determine whether they are used productively or for off-the-task purposes. In this study students were invited to voluntarily bring their personal wireless computers to introductory physics classes in order to utilize them with DyKnow software. We compare performance of students who consistently used computers in classroom with those who did so less frequently or not at all. We also gauge how student attitudes and recommendations related to DyKnow software and Tablet PCs vary by the type of computer that was available to them in this course.

1. PROBLEM STATEMENT AND CONTEXT

A recent article in the Washington Post titled “More colleges, professors shutting down laptops and other digital distractions” [6] cites a number of references that question the educational benefits of allowing students to use wireless ready computers in classrooms. Ideally mobile computers would be used to take notes and search for relevant information. If misused, however, they may be a distraction for the user, as well as for students in vicinity and for the instructor. Fried [4] showed that students who use wireless laptops in classes may be frequently distracted from the task at hand which negatively reflects on their performance. Barak at al [1] found that if wireless laptops are employed only when the instructor requires the students to do so, they may productively facilitate active learning. Otherwise, they may be used for Web surfing and e-mail messaging. Mortkowitz [6] contends Tablet PCs or devices like iPad will only make it harder for students to pay attention in class. Because they can be used to read textbooks, it might be more difficult for professors to determine which students are goofing off and which are studying [6]. Sisson [7] however, very successfully deployed Tablet PCs to facilitate collaborative problem solving and saw considerable test score increase as well as significantly improved retention (>2 standard deviations) in her first semester algebra-based physics course. The authors of the present study utilized students’ personal mobile computers (laptops and tablet PCs) in order to capitalize on their productive features in improving student learning in an algebra-based introductory physics course. At the same time, we wanted to minimize possible negative effects. The course was taught in a lecture setting at Columbus State University.

2. SOLUTION EMPLOYED

In Spring semester of 2010 we invited and encouraged students to bring their wireless computers to physics classes and we deployed DyKnow software [2] in this course to increase students’ active participation in the lecture and to facilitate productive note taking. The main advantages associated with using DyKnow software include [5]: (1) elimination of the need to copy the displayed content, (2) availability of multiple channels of real-time feedback for instructor and (3) facilitated group work through simultaneous annotation of slides. DyKnow can be utilized with laptops and tablet PCs but unlike laptops, Tablet PCs allow for handwritten electronic inking which is extremely handy in areas that use a lot of symbolic annotations such as physics, other STEM fields (Science, Technology, Engineering and Math) and the like.

A disadvantage of applying the software in our setting was that computers were not required and we relied on students' voluntary participation for bringing wireless ready devices to classes. Expecting mostly laptop computers without inking input, a concern was whether students will be able to use them effectively to take notes in a physics course.

On the first day of classes in Spring 2010, the instructor determined that 46 out of 51 present students owned a wireless ready laptop. Shortly thereafter, the number of students who carried their laptop to classes stabilized at around 60% of the attendees (and attendance number was typically in lower to middle 40-ies. This was sufficient to enable a majority of students to capitalize on productive software features and for the instructor to capitalize on a real-time feedback options. In the first half of the semester, four students purchased Tablet PC and used them consistently in classes.

Formative assessment tools were used throughout the semester. Students with computers were regularly logging into DyKnow and were consistently providing feedback through "status of understanding" feature [3] and multiple-choice answers through the pooling option. Students were also actively submitting slides in response to open-ended questions and problems. Because not all students used computers, it was also necessary to resort to traditional, verbal methods of eliciting questions and other feedback from students. The instructor did not use monitoring feature of the DyKnow software to control various aspects of students' computers. Therefore, the way in which students utilized their computers was completely up to them. In this setting, we were interested to answer the following research questions: (1) Given possible advantages and disadvantages of using this technology in a voluntary manner, will it be beneficial for students to bring computers to classes? (2) What will be student perceptions of DyKnow facilitated learning in our setting and (3) given some students use Tablet PCs, will their performance differ depending on whether they used a laptop or a pen input computer?

3. EVALUATION

In order to answer these questions, we used several methods: (1) A classroom observation by external evaluator, (2) a comprehensive, end-of-semester online survey that gauged student's usage patterns and attitudes regarding the use of wireless computers and DyKnow in aiding their learning and (3) a class-wide focus group session run by the same external evaluator. The collected data was examined to determine possible correlations between usage patterns and standard measures of student performance (the test scores and the final grade).

Observational data in the classroom setting did indicate a substantial degree of engagement among the students using computers. Computers facilitated student group work and real time feedback to the instructor. During the entire class session, only one student with a laptop in use was briefly observed using that laptop for any task that was not related to the class. Students without computers used paper and pencil for note taking activities typically observed in lecture settings while also participating in group and classroom discussions.

The advantages of this technology that surfaced during the focus group include increased student-student and student-teacher interaction for the whole class, easy reviewing and ability to seek content-related input without personal identification if help is needed. Students also found software helpful for organizing notes and helpful to focus on content instead on note taking. The disadvantages brought up included difficulty with participation if without computer, difficulty taking notes by hand aside laptop (due to the physical space limitations), the temptation to check email during class and technical issues.

Out of 53 students enrolled in class 14 days into the semester, 37 took the end-of-semester survey (69.8%). One student dropped the course (after the second test) and two more stopped attending halfway through the semester (one of those did take the survey). All survey respondents indicated they personally owned a computer, either a desktop (17) a laptop (29), a Tablet PC (3), or more than one of these types, most frequently a desktop and a laptop (11). Six students owned a desktop only. In the Table 1 we compare the patterns of computer usage determined through survey with two measures of student performance: (1) The average scores of the taken tests and (2) the final grade score. For measure (1) only taken tests were included so this indicator is not affected by a missed or not taken test. All test questions were standard or slightly modified end-of-the chapter, open-ended problems typical for algebra-based introductory physics course. The end of the semester score combined the test results (72%), (online) homework (22%) and (online and class) quizzes (6%). The course grade score represents a comprehensive course success and it would be affected by omitted assignments.

Table 1: Computer usage and Student Success Comparisons

In Spring 2010, on average		Cate-gory	All and Each Category			Categories 5 vs 4,3,2,1		
I was bringing my computer to physics class:		**Code**	**N**	**Avg. %**	**SD**	**N**	**Avg. %**	**SD**
Avg. Scores Of Taken Tests	All responses		37	60.88	22.92			
	Three times per week (all)	**5**	21	67.49	18.20	21	67.49	18.20
	Two times per week	**4**	1	10.67	NA			
	Once per week	**3**	3	49.44	15.67	8	45.03	25.80
	Once or twice per month	**2**	3	48.08	37.13			
	Once or twice in semester	**1**	1	57.00	NA			
	Never	**0**	8	59.39	25.85			
	1) Kruskal-Wallis and 2) Mann-Whitney test p-values			**p=0.365**			**p=0.040**	
I was bringing my computer to physics class:		**Code**	**N**	**Avg. %**	**SD**	**N**	**Avg. %**	**SD**
Course Grade Result	All responses		37	72.26	22.51			
	Three times per week (all)	**5**	21	80.12	15.35	21	80.12	15.35
	Two times per week	**4**	1	30.17	NA			
	Once per week	**3**	3	59.41	18.93	8	56.66	23.25
	Once or twice per month	**2**	3	60.19	33.51			
	Once or twice in semester	**1**	1	64.34	NA			
	Never	**0**	8	67.24	30.01			
	1) Kruskal-Wallis and 2) Mann-Whitney test p-values			**p=0.350**			**p=0.019**	

Since our samples were not randomly assigned, we used nonparametric statistic which gave more conservative results. Thus we used Kruskal-Wallis 1-way ANOVA for comparing 3 and more groups and Mann-Whitney U-test p-values for two group comparison. As shown in the Table 1, students who brought computers most frequently to classes performed the best, both in terms of the test scores and overall course grade. However, students who never brought computers performed better than those who brought them in less frequently or occasionally. This might be an indication that students who did not bring computers to class consistently either did not use them effectively or they used computers for activities not related to the course. While differences between respective scores across all categories are not significant, comparison of scores for students who always used computers (category 5) with those who used them less frequently or occasionally (categories 4,3,2,1) show difference significant to 0.05 level both according to average test scores (p=0.040) and according to the course grade scores (p=0.019). The difference strongly favors consistent computer users. Further, when all computer users are compared (with nonusers omitted) bivariate nonparametric correlation (Spearman's Rho) between the computer presence and our two success indicators is significant: at 0.1 level with average test scores (p=0.063), and at 0.05 level with the final grade (p=0.028).

In the Table 2 we group students according to their reported cumulative computing activity which combines a) bringing computers to classes, b) logging on to DyKnow and c) actively participating in DyKnow facilitated activities. Students in the "Always" category did all of these three during all the classes. Students in the "Never" category never did any of them (all because they were not bringing computers). "Inconsistent" students fall anywhere in-between the other two. We than compare results of students in these categories with the background measures for students for which both the HS GPA and the SAT Math score were present in the university database (math readiness is generally a very good predictor of student success in physics courses). Both of these background data was available for 23 students (out of 37 who took the survey) and their results and background scores are shown below.

Table 2: Comparison of Students' Computer & DyKnow Activity with Success Level

				Tests Taken	Course Grade	SAT Math	HS GPA
I bring computer AND I log on to DyKnow AND I actively participate	**Always**	**N=7**	**Avg**	**67.0**	**81.4**	**520.0**	**3.05**
			SD	15.0	12.0	21.9	0.26
	Inconsistent	**N=11**	**Avg**	**57**	**66.8**	**530.9**	**3.38**
			SD	30.3	27.5	97.9	0.43
	Never	**N=5**	**Avg**	**58.4**	**67.7**	**500.0**	**3.22**
			SD	29.2	32.7	99.7	0.38

When these background measures are compared with respect to students' cumulative computing activity (as defined above) we find that among the three student categories it is the inconsistent user group that has both the highest SAT Math scores and HS GPA. At the same time this group has the lowest dependent measures scores. Consistent, i.e. "Always" users performed better than either of the other two groups in both dependent measures while having the second best SAT Math score and the lowest HS GPA. Further details of student performance and their background comparison will be reported elsewhere.

For all 37 participants, this was the first time they used DyKnow. 28 survey participants reported using it in classroom, 24 at home/dorm, 9 on campus and 7 elsewhere outside the campus. Outside the classroom, they reported using DyKnow on average 1.9 hours +/- 1.65 hours per week. Five students never used DyKnow themselves other than experiencing it in classroom. Overall, a large majority of students report positive attitudes about using DyKnow software. However this attitude very much depends on the type of computer that students used, with Tablet PC users being the most positive. For example 81% of all respondents (N=37) and 100% of Tablet PC users (N=3) agree or strongly agree that using DyKnow was enjoyable. For 70% of all respondents and 100% Tablet PC users DyKnow enhanced interaction with instructor. The greatest difference between responses of Tablet PC users and all other responses is related to note taking. While all (100%) Tablet PC users agree or strongly agree that DyKnow helped them take better notes, only half (51%) of all respondents do. The difference in these responses may well be due to the limited space on chair desks used in the classroom: it would be difficult for laptop users to both take notes on paper and use a mobile computer on them. It is interesting that five students who did not use DyKnow at all on their personal computers (but rather simply through attending classes in which it was used to enhance interaction) also reported quite positive attitudes toward DyKnow. For 80% of them using DyKnow was enjoyable.

Table 3 breaks answers related to overall DyKnow experience and recommendations for further usage in this course per tablet PC using opportunity. It again shows that tablet PC owners were the most pleased DyKnow users but those who had chance to use borrowed tablet PCs had better experience and higher recommendations than other users. Students who did not have a chance to use tablet PCs were not asked about their experience with them but were asked for recommendations based on seeing others (the instructor and other students) using tablet PCs. Again, unlike nonusers, Tablet PC users highly recommend them, with average recommendation differences between the user groups significant at 0.1 level (p=0.057, Kruskal-Wallis ANOVA).

Table 3: DyKnow and Tablet PC experience and recommendations for usage in physics course

		Cate-gory	DyKnow			Tablet PC		
Did you have opportunity to use Tablet PC, either yours or borrowed, in Physics I this semester?		**Code**	**N**	**Avg. %**	**SD**	**N**	**Avg. %**	**SD**
Overall Experience	All responses		37	3.51	1.17	6	4.33	0.52
	Yes, I used my personal Tablet PC	**2**	3	4.33	0.58	3	4.67	0.58
	Yes, I used a borrowed Tablet PC	**1**	3	3.67	0.58	3	4.00	0.00
	No, I did not use a Tablet PC	**0**	31	3.42	1.23	NA	NA	NA
	Kruskal-Wallis ANOVA p-values			p=0.404			p=0.114	
Did you have opportunity to use Tablet PC, either yours or borrowed, in Physics I this semester?		**Code**	**N**	**Avg. %**	**SD**	**N**	**Avg. %**	**SD**
Recomm-endations for this course	All responses		37	3.57	1.26	37	3.51	1.17
	Yes, I used my personal Tablet PC	**2**	3	4.67	0.58	3	4.67	0.58
	Yes, I used a borrowed Tablet PC	**1**	3	4.00	0.00	3	4.33	0.58
	No, I did not use a Tablet PC	**0**	31	3.42	1.31	31	3.32	1.17
	Kruskal-Wallis ANOVA p-values			p=0.176			p=0.057	

In Table 4 we compare test performance and course success of students who used different computer types. Both of these measures show that tablet users performed much better than either laptop or desktop (only) users. The difference between tablet users and all other survey respondents is significant at 0.1 level (p=0.059 for test scores and p=0.095 for the course grade).

Table 4: Computer type used and Student Success Comparisons

		Cate-gory	All and Each Category			Categories 3 vs 2,1,0		
		Code	**N**	**Avg. %**	**SD**	**N**	**Avg. %**	**SD**
Avg. Scores Of Taken Tests	All responses		37	60.88	22.92			
	Tablet	**3**	3	81.03	3.88	3	81.03	3.88
	Laptop	**2**	28	60.25	21.32			
	Desktop	**1**	6	53.75	31.84			
	None	**0**	0	NA	NA	34	59.10	23.06
	1) Kruskal-Wallis and 2) Mann-Whitney test p-values			**p=0.162**			**p=0.059**	
The top mobile computer I own		**Code**	**N**	**Avg. %**	**SD**	**N**	**Avg. %**	**SD**
Course Grade Result	All responses		37	72.26	22.51			
	Tablet	**3**	3	90.72	2.69	3	90.72	2.69
	Laptop	**2**	28	72.80	19.58			
	Desktop	**1**	6	60.54	34.72			
	None	**0**	0	NA	NA	34	70.63	22.78
	1) Kruskal-Wallis and 2) Mann-Whitney test p-values			**p=0.244**			**p=0.095**	

In conclusion, when computer-facilitated active learning experience is provided, consistent wireless-computer classroom users are likely to benefit from it more than non-users. However, inconsistent and sporadic users are likely harmed by the availability of the computer. Therefore ways of controlling the off-the-task computer usage, possibly such as DyKnow monitor are necessary to prevent harmful effects of inconsistent and off-the-task usage. Among consistent users, Tablet PC owners surpass the laptop users both in terms of class performance and the satisfaction with technology. This is likely due to the ease of taking notes with the tablet PC. Overall, with consistent use and adequate control of misusage, wireless laptops (and especially tablet PCs) in classrooms are likely to be an asset rather than disadvantage for students.

4. ACKNOWLEGEMENTS

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