Laptop computers in an all-girls school: hearing the student voice in an evaluation of technology use

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Summary

The Hewitt School, an independent all girls schools offering grades K to 12 in New York City, recently began to require that its upper school students purchase and use laptop computers. This paper will describe the evaluation of this requirement, with special focus on how paying attention to student voice can reveal how students understand their computers, and in turn, how the school can meet its long term goals for technology use. This study was based upon a constructivist framework (Novak 1998) which examines what students already know about a subject, and which then builds the curriculum on this foundation. This evaluation utilized multiple methods, including written surveys collecting both quantitative and qualitative data, concept maps and open-ended questions. This paper will focus on results from three types of student data: student computer use in hours, student value of the use of the computer by subject studied, and students' detailed understanding of computer technology as depicted in open-ended questions.

This study is important because it depicts the effects of laptop computers on a school when the school makes a full commitment, with both technological and pedagogical support, to technology-based learning. In this context, this presentation will focus on three main findings. First, while computer use increased both at school and at home, laptops were strongly correlated with increases in computer use at school. Second, students valued the use of the computer for four subjects above average (computer, English, history, science), while students valued the use of the computer for three subjects below average (art, languages other than English, math). Laptop students valued the use of the computer for the standard academic subjects higher than non-laptop students. Third, as indicated by open ended questions (which probe directly from the value question), laptop computers were regarded as devices for typing. In addition, students valued their computers because the computers helped students produce work which is neat, and helped students stay organized.

Overall, the use of laptops has been a success, although there is room for growth.

Design of the project

This paper, reporting on the results from the first year of a two to three year project, utilized surveys, open ended questions, and concept maps to assess the impact on student learning of Hewitt's technology program, and specifically the requirement that students purchase and use laptop computers. Moreover, by learning from students' experience with the laptops, Hewitt will be able to improve the program.

Methods

The effect of a school's investment in technology is often measured in the hours students use the computers (Ricci 1999). This study used a survey in which students were asked to report how often they used the computer at school, at home, and at other places. While knowing how often students use the computer is an important and useful measure, it is an incomplete measure. The use of technology can be more or less efficient, as well as varying in the extent to which it simply replaces traditional ways of working versus providing educational capacities which are not possible using traditional ways of working. Furthermore, an earlier technology use related study with which the author was involved used a Likert style survey which exhibited clear problems of regression to the mean: students started with a self assessment of their technology use which was high, experienced a new use of technology which both improved their skills and expanded their horizons, and then had nowhere to go but down for their self assessment of technology use at the end of the project, even though their actual technology skills and attitudes most likely increased.

To control for regression to the mean in the Hewitt Laptop study, a question was devised in which students were asked to assign points to each of seven subjects out of a total of 100. Students were asked to provide this rating for both the subjects themselves, and for the use of the computer for those subjects. This meant that while students still had to put a number on an abstract, fuzzy measure, they could make comparisons between seven components of this measure, thereby making their assessments more accurate. This approach is consistent with a similar problem, known as the good cause dump hypothesis, found in contingent value methodology which is used in the field of environmental economics. "This hypothesis asserts that agents can be viewed as having a WTP [Willingness To Pay] for a basket of 'Good Causes' and that when a CVM [Contingent Value Method] researcher comes along and asks them to value any constituent 'good cause' in this basket, they 'dump the whole value for the basket into the stated WTP." (Harrison 1992) Based upon this work, it is reasonable to suppose that when students are asked to value their use of the computer for different subjects, each subject asked separately, they might dump their entire valuation of the use of the computer into each subject. Asking for valuations of subjects in relation to each other should control for this potential source of error.

This valuing of the use of computers for the different subject areas was probed further by asking students to select one subject for which they valued the use of

computer and one subject for which they did not value the use of the computer, and to discuss why they valued or did not value the use of the computer for these subjects. Concept maps, a technique for representing student understanding which has been used extensively in assessment (Ruiz-Primo and Shavelson 1996; Ruiz-Primo, Schultz and Shavelson 1997; Novak 1998), were used to supplement these open ended questions. An essay style open-ended question was also completed by the students.

Context

The Hewitt school is an independent, all-girls school in New York City with 30 students per grade from Kindergarten to Grade 12. The school has over the past several years made a substantial investment in technology, including at least one computer in each class room connected to a large monitor, multiple power and ethernet connections in each classroom, electronic whiteboards in many classrooms, and 3 full-time staff people who provide computer support (one of whom is primarily technical support, a second who provides technical as well as computer related pedagogical support in addition to teaching the high school computer classes, and the third who teaches the lower and middle school computer classes).

At the start of the 1998-99 school year, students in Grades 8 and 10 were required to purchase a laptop computer. Students were given a choice of two models. The primary difference between the models was whether the screen was active or passive matrix. Thus, all students had access anytime, anywhere to computers with nearly equal capabilities. Most students have access to the internet from home, many via AOL.

Since all students in Grades 8 and 10 were required to purchase laptops, data were collected from all students in Grade 6 to provide a comparison group, and to establish a baseline for the longitudinal portion of the study. Data were collected at the start, middle, and at the end of the year from Grades 6, 8, and 10. Data were also collected from Grades 7 and 9 at the end of the year to establish a baseline since those students will start using laptops at the beginning of 1999-2000. Given that all students in Grades 8 and 10 were laptop students, it was necessary to use a sampling strategy where the control and treatment groups differ on a potentially significant variable: age. However, since the students in each grade came from similar backgrounds and homes, and were taught with similar curricula (sometimes by the same teachers), the samples can be regarded as equivalent. Also, the primary purpose of the study was to provide feedback to the school, so generalizability to larger populations was a secondary concern. Nonetheless, it has been shown that laptop projects can be carried out in public schools (Ricci 1999), so the results reported here are likely to be applicable to larger populations at least in part.

Results

Use of the Computer in hours per week

While computer use increased both at school and at home, laptops were strongly correlated with increases in computer use at school. The following section presents evidence to support this claim.

Students in laptop grades reported an increase of 5.2 hours per week of computer use in school, in comparison to Grade 6 (the non-laptop grade in the study) who reported an increase of 0.5 hours per week of computer use in school from the first survey to the third survey (June 1998 to June 1999). This difference between laptop and non-laptop students was statistically significant (P = 0.00) using an independent samples T test. In contrast, students in the laptop grades increased their computer use at home by 8.0 hours per week, with Grade 6 students increasing their home computer use by a similar 7.0 hours per week. This difference between laptop and non-laptop students was not significant (P = 0.66). Tables 1 and 2 below break out these results by all locations of computer use, and by grade. The traditional guideline for significance holds that P values of 0.05 or lower are significant.

Table 1: Mean change in use of the computer (hours per week) from June 1998 to June 1999 (by laptop status)

	Home	School	Other	Total
Laptop Students	8.0	5.2	0.2	13.4
Non-laptop students	7.0	0.5	-0.1	7.4
P	0.66	0.00	0.58	0.05

Table 2: Mean change in use of the computer (hours per week) from June 1998 to June 1999 (by grade)

	Home	School	Other	Total
Grade 6	7.0	0.5	-0.1	7.4
Grade 8	8.0	5.0	0.0	13.0
Grade 10	8.1	6.1	1.0	15.2

It could be argued that the differences seen in Tables 1 and 2 are a result of the difference in the students' ages, instead of the difference in the students' laptop status. After all, Grades 8 and 10 are part of the High School at Hewitt, but Grade 6 is part of the Lower School. The section below will show that such a contention would be false.

While Grades 7 and 9 were not included in the first part of the study due to logistical constraints, they were included in the data collection for the June 1999 survey. At the end of the year, laptop students reported mean computer use at

school of 11.1 hours per week, compared to 2.2 for non laptop students (significant, P = 0.00). At the end of the year, laptop students reported mean computer use at home of 15.9 hours per week, compared to 12.2 hours per week for non laptop students (significant, P = 0.03). Use of the computer in locations other than school or home was negligible for all students, with an overall mean of 0.5 hours per week (no significant difference between laptop and non-laptop students, P = 0.30). The full breakdown by location and grade is shown below in Tables 3 and 4.

Table 3: Mean hours per week of computer use reported at the end of the year (by laptop status)

	Home	School	Other	Total
Laptop Students	15.9	11.1	0.3	27.4
Non-Laptop students	12.2	2.2	0.6	15.0
P	0.03	0.00	0.30	0.00

Table 4: Mean hours per week of computer use reported at the end of the year (by grade)

	Home	School	Other	Total
Grade 6	12.5	2.1	0.6	15.1
Grade 7	13.4	2.4	0.7	16.5
Grade 8	14.1	8.4	0.4	22.8
Grade 9	7.7	2.1	0.3	10.1
Grade 10	18.7	15.6	0.3	34.6

If the differences in the change in computer use as seen in Table 1 were due to difference in students' ages, one would expect that Grade 9 students would have had similar June 1999 use of the computer at school as the Grade 8 and 10 laptop students. An examination of Table 4 shows this is not the case.

One could also argue that the differences seen in Table 1 are due to differences in the initial June 1998 computer use as reported in Survey one.

We found no significant difference between laptop and non-laptop students on Survey 1 in terms of computer use at home (7.4 hours per week for laptop students compared to 5.5 hours per week for non-laptop students, P = 0.12). There was a significant difference on Survey 1 in terms of computer use at school (1.5 hours per week for non-laptop students compared to 4.5 hours per week for laptop students, P = 0.01). There was also a significant difference on Survey 1 in terms of total computer use. The full breakdown by location and grade is shown in Tables 5 and 6 below.

Table 5: Mean hours per week of computer use reported for June 1998 (by laptop status)

	Home	School	Other	Total
Laptop Students	7.4	4.5	0.3	12.2
Non-laptop students	5.5	1.5	0.9	7.9
P	0.12	0.01	0.10	0.03

Table 6: Mean hours per week of computer use reported for June 1998 (by grade)

	Home	School	Other	Total
Grade 6	5.5	1.5	0.9	7.9
Grade 8	6.4	3.7	0.4	10.4
Grade 10	12.4	8.2	0.0	20.6

To determine whether these initial differences favoring laptop students account for the differences in the change in use, an ANOVA was run for the change in computer use at school from Survey 1 to Survey 3, where use of the computer at school on Survey 1 was factored out. The difference between the change for laptop students compared to non-laptop students was still significant where P = 0.00. Similarly, when an ANOVA was run for the change in total computer use from Survey 1 to Survey 3, where total use of the computer on Survey 1 was factored out, the difference between the change for laptop students compared to non-laptop students was still significant where P = 0.01.

Based upon this evidence, one can conclude that the Hewitt laptop students used computers significantly more both at school and in total, and that this more frequent use is a result of the students having laptops.

Valuing the computer by subject

Students valued the use of the computer for four subjects above average (computer, English, history, science), while students valued the use of the computer for three subjects below average (art, languages other than English, math). This pattern was stable for all grades in all three surveys.

This question asked students to assign points to each subject such that the total for each question would add up to 100. Thus, these results are on a relative scale. They should not be taken as an absolute assessment of how students feel about particular subjects, especially since some students commented that they value all of their subjects highly. In addition, some of the low scores are the result of students not taking particular subjects (and therefore not valuing them). Since there were seven subjects in the questions, an average score would be 14.3 (the student valued all subjects equally). Thus, means below 14.3 can be understood as below average, and means above 14.3 can be understood as above average.

Laptop students valued the use of the computer for computer class less than non-laptop students, which given the structure of the value question, indicates that laptop students generally valued the use of the computer for all non-computer subjects (i.e. the standard academic subjects) higher than non-laptop students. This result is consistent with Hewitt's efforts to integrate computers into the curriculum, including providing a large portion of computer instruction on a just in time basis in classes where the skills are needed, rather than in a separate computer class. This result can be confirmed by examining the grade means in Table 8 because both laptop grade means are lower than all of the non-laptop grade means. Significant differences were found favoring laptop students for both English (P = 0.01) and Science (P = 0.03). These results are consistent with students' valuing the computer to find information for and to type up reports. However, in the case of both English and Science, the laptop grade means are not always higher than the non-laptop grade means, so while the differences are significant, it would be prudent to regard the results for English and Science as tentative. The full breakdown by subject and grade are shown below in Tables 7 and 8. The result for English is stronger than the result for Science, both due to the lower P value, but also because when the difference between Survey 1 and Survey 3 is calculated, the only significant result is that laptop students increased the value they attached to the use of the computer for English (i.e. their average June 1999 result was 7.4 higher than their June 1998 result, while non-laptop students' change was -5.7 (P = 0.01)). The point here is that while each subject related result should be taken as tentative, both the qualitative and quantitative evidence suggest that laptops had a positive effect for the use of the computer for English.

These results show that, for the most part, laptops do not favor any particular subject. Laptops are a platform on which to build whatever learning the Hewitt School may wish to emphasize.

Table 7: How valuable is the COMPUTER to your studies in each of the following subjects? (from June 1999 Survey, by laptop status)

	Art	Computer	English	History	Language	Math	Science
Laptop students	03.5	15.7	28.8	20.2	06.8	05.2	19.8
Non-laptop students	03.3	24.8	22.6	20.1	06.3	07.0	15.9
P	0.90	0.01	0.01	0.97	0.74	0.13	0.03

Table 8: How valuable is the COMPUTER to your studies in each of the following subjects? (from June 1999 Survey, by grade)

Grade	Art	Computer	English	History	Language	Math	Science
6	04.0	25.0	26.3	19.8	06.8	04.6	13.5
7	03.7	23.5	16.7	21.6	06.6	09.8	18.2
8	02.5	16.1	33.3	21.2	05.9	06.2	14.9
9	00.6	28.2	30.6	16.5	04.1	04.7	15.2
10	05.0	15.1	22.0	18.7	08.1	03.7	27.4

Part of the purpose of asking students how they valued each subject was to get students to use the results to explain why they valued or did not value the use of the computer for each subject. This is a way to hear the students' voice from a large number of students that is similar (in kind if not in depth) to what would be obtained from an interview. Two questions asked students to choose one subject for which they did and did not highly value, respectively, the use of the computer. The responses to these questions give suggestions that would allow Hewitt to capitalize upon its successes while addressing the subjects in which computer use is currently not valued. Table 9 summarizes the results by subject.

Table 9: Summary of reasons to value and not value each subject (#V = number of students responding with reasons to value that subject, and #NV = number of students responding with reasons to not value that subject).

Subject	# V	Why Highly Valued	# NV	Why Not Highly Valued
Art	4	• Sometimes uses photoshop with their laptops during the entire period. • Has music software that allows her to compose. • "Art on the computer is important to me because it makes the report I might be doing look good."	56	• computer not required in this class. • art uses hands and body. • art is drawing, not typing.
English	54	• Typing assignments is required. • Helps being organized. • Spell checking, thesaurus, Dictionary, Grammar Checker. • Editing. • Internet access for research reports. • Neatness. • Writing is easy on the laptop. • Saves time.	3	• Never been asked to use the computer for this subject (Grade 6).
History	22	• Take notes. • Look up information. • Neatness: "I take pride in my work." • Computer used the most in this subject. • Research projects. • Presentations. • Homework requires writing. • Easier and faster to type. • Review old Homework for tests. • Encarta, Web, AOL. • E-texts easier than books.	0	
Languages	1	• All Homework must be typed. • Easier to type assignments. • Homework looks neater when typed.	13	• Doesn't check grammar. • Most work done in workbook. • Can't do accents on computer. • student doesn't take a language. • Nothing to type up.
Math	2	* Ways in which students report using the computer for math: • Graphs. • Problem of the week. • Calculator / Graphing Calculator. • Excel and formulas.	36	• Need a pencil for math. • Take notes in notebook. • Hard to type equations. • No essays required. • Calculator makes graphs for us, so don't need computer. • Get credit for showing your work. • Have to find the answer yourself and be able to explain it.
Science	17	• Take notes on the computer. • Go to the web. • Do Homework. • Less time to type (than to write similar document). • More organized. • Pictures and graphs can be pasted into notes. • Computer used for labs. • Print notes to study for tests.	0	

General reasons students value their computers

As indicated by open-ended questions (which probe directly from the value question), and the concept maps, laptop computers were regarded as devices for typing. Students valued their computers helping them produce work which was neat, and also valued the way their computers helped them to stay organized. These qualitative results provided confirmation through converging lines of evidence that students were making quantitative assessments of value which were accurate.

The number of "mentions" in the open-ended questions for each reason to value the computer by grade and survey are shown below in Table 10. The second number in each cell is the number of students who completed that survey in each grade.

Table 10: Mentions in the open-ended questions for several reasons to value the computer.

A. Mentions of valuing computers as devices for typing

	Grade 6	Grade 7	Grade 8	Grade 9	Grade 10
Survey 1	6/31	NA	1/25	NA	0/5
Survey 2	10/32	NA	11/28	NA	8/17
Survey 3	7/29	12/31	12/27	8/11	11/17

B. Mentions of valuing computers to search for information: Internet or CD-roms

	Grade 6	Grade 7	Grade 8	Grade 9	Grade 10
Survey 1	3/31	NA	4/25	NA	2/5
Survey 2	14/32	NA	12/28	NA	6/17
Survey 3	6/29	8/31	4/27	1/11	7/17

C. Mentions of valuing the computer for neatness.

	Grade 6	Grade 7	Grade 8	Grade 9	Grade 10
Survey 1	2/31	NA	3/25	NA	1/5
Survey 2	0/32	NA	2/28	NA	0/17
Survey 3	0/29	5/31	4/27	0/11	2/17

D. Mentions of valuing the computer for organization.

	Grade 6	Grade 7	Grade 8	Grade 9	Grade 10
Survey 1	0/31	NA	0/25	NA	0/5
Survey 2	0/32	NA	0/28	NA	2/17
Survey 3	0/29	0/31	2/27	4/11	8/17

Valuing the computer as a device for typing appears strongly at all grade levels. To some extent, these numbers probably understate the true prevelance because this measure only counts a mention when a student writes directly about typing

(talking about writing alone did not count here). Some of the valuing of typing can be understood by the mentions of valuing the computer for neatness and organization of work. Some evidence shows that students see the three constructs as related to each other. Valuing of neatness is relatively stable over time, while valuing of organization shows up primarily in later grades and surveys. This issue would be worth asking a follow up question on a future survey.

Searching for information, often for reports, is another theme that appeared consistently across grade levels and surveys. Thus, while some of the evidence would suggest that students were using the computers in fairly basic ways (i.e. typing), the more the data are mined, the more evidence emerges that students are using their skills to use the computer in more sophisticated ways. This result is consistent with the idea that a school must first build a technology learning platform of basic skills before it can build the next stage. Furthermore, while it is too soon to comment definitively, initial evidence from the second year of data collection indicates that both students and teachers are progressively learning to use their computers in more sophisticated ways that go beyond typing alone.

General Student Attitudes towards technology as expressed in the "Cycle in the Life" essays

In the middle of the year, students were asked to write a "Cycle in the Life" essay. "Cycle" in this case refers to Hewitt's school week which runs on a 6 day cycle. The Cycle in the Life essays were analysed to determine general student attitudes towards technology. The instructions for this essay are shown below:

> Write a "cycle in the life" essay showing your use of technology, especially the laptops. In other words, you want to communicate what is typical technology use in the life of a Hewitt student this year. Try to strike a balance between commenting on big themes and describing the details of technology use. Write for about 30 minutes.

In this analysis, all of the completed essays were examined to see if students had positive, neutral, or negative attitudes towards technology. Essays which commented that technology or computers were helpful, important, or valuable were counted as indicating positive attitudes. Essays which commented that computers were unhelpful or a burden were counted as negative. Essays which did not use any of these terms, or which used both terms equally were counted as neutral.

Among the tenth graders, four had positive attitudes towards technology, and none had neutral or negative attitudes. Among eighth graders, ten had positive attitudes, five had neutral attitudes, and none had negative attitudes. Among sixth graders, nine had positive attitudes, fifteen had neutral attitudes, and none had negative attitudes. A quote from each grade is below.

"The technology at Hewitt has been most helpful to me and my learning experiences and I hope they continue to use this system of learning because I think it might be very helpful for our future. Because we are now living in a world of computers and to be able to use all of the programs gives us a huge advantage, [compared] to those who can not like our parents. Basically I really like the technology at Hewitt and I hope they continue to use it."
– Grade 10 student

"Technology plays an important part in my everyday life because I realize how so many times I have been stuck in a jam and need email or a fax machine to help me out. I can't imagine the world without technology. My day is related to technology because how would I be able to get up, work as well in school and talk to friends. I am glad to be a part of our generation that is so closely related to technology."
– Grade 8 student

"I started out the year not wanting to even touch computers but I realized it helped me out a lot with grammar and spelling. I have just started to use AOL because I just found out I had it. I don't usually like to type but I have gotten faster which is very good. I think in total I like the computer and think it makes doing school work a little easier. All in all I think that you can say I use the computer more that I have ever have and that I have learned that computers are your friends and not your enemy."
– Grade 6 student

Implications

Changes in hours per week of computer use at home compared to at school suggest that while laptops provide equal access to technology for all students, laptops have their most dramatic impact on computer use at school because teachers are assured that all of their students will have access to computers during class time, and students are assured that they will have access to computers during their free study time at school. Laptops also offer advantages in that teachers can flexibly organize instruction with students working individually or collaboratively.

The value question provides feedback to the school that shows how the laptops were being used by the students. In the case of Hewitt, students mostly used the computer to find information and type up reports. Subjects for which the use of the computer was valued below average are strongly associated with difficulties in typing for those subjects, such as accents in languages other than English, and equations in math. Below average values are not necessarily a problem, particularly since students distinguished between using the computer to enhance the presentation of their work, versus having the computer do students' work for them. For instance, students discussed the need to show their work in math, and how if the computer did the math for them, they wouldn't be learning. One way

for a school, that wants students to use the computer for more than typing, to use these results would be to incorporate programs which extend the capabilities of a word processor. Such programs include an equation editor, and bibliographic database program.

The value question also shows that while students consistently valued the use of the computer for certain subjects, these preferences are largely unrelated to laptop status. The exception appears to be English. The possible effect in English is consistent with students' seeing laptops as typing and writing devices, and with Hewitt's desire to focus on basic computer skills before tackling more complex instructional challenges. Thus, laptops represent a platform upon which a school can build any learning it wishes to emphasize.

The result that students value the computer because it helps them to stay organized has several implications. It is consistent with the goal of instilling basic study and technology skills. It is consistent with the philosophy of constructivism which argues that students' learning is most effective when they can actively organize and integrate new knowledge with existing knowledge. Finally, it is consistent with the elusive goal of enabling learning which spans multiple years, thus helping students to break the all too prevalent pattern of learn and forget, learn and forget, resulting in learning which helps students to capitalize on all of their subjects to take their learning to deeper levels of understanding.

In summary, one can say, based upon the evidence presented in this paper, that the Hewitt School was successful in its objective of increasing computer use at school and that this success is due to the School's chosen strategy: the introduction of laptops. The use of the laptops has focussed largely on basic skills, such as typing, and more sophisticated skills, such as organization and internet searching. While these skills are in some ways basic, they are also critical especially when considered in light of the possible laptop effect in English.

The implementation has not been without problems, including the kind of virus problems that afflict many organizations (not just schools) these days. The main student complaint about the laptop program was the weight of the laptops. Students also complained about the bags which came with the laptops: they were awkward to carry with a regular bookbag (athletes sometimes had to carry three bags: laptop, books, and sports gear). These problems are addressable. The weight problem has as much to do with the many books students need as it does with the laptops themselves. Some students suggested, and Hewitt has adopted, a policy of encouraging students to get two copies of their textbooks so these do not have to be carried from home to school and back. Some students also suggested moving to electronic books. This issue is being considered in the second year of the evaluation. The bag issue was not just about weight. Some students were concerned that the standard bag was also a safety issue because it made it obvious to strangers that the student was carrying a laptop. Students have found alternative bags which allow them to carry the laptop and books in one bag that does not look like an obvious laptop bag. A few students

complained about the lack of network plugs in places where they have study halls. Some of these places are not obvious candidates for network expansion if their primary use is all that is considered, such as the cafeteria.

Even with such problems, student attitudes toward technology are positive. Especially in the context of an all-girls school, achieving greater computer use is an important accomplishment. As the next step, Hewitt needs to decide what learning objectives are most important and find the best ways to use the computer-as-learning-platform to accomplish those objectives.

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Robert Abrams is available to provide evaluation, research, and professional development services. If interested, please email bob@robertabrams.net, or call 212-369-6323. Laptop projects are obviously a speciality, but any project where a school wants to help teachers and students create meaningful learning will be considered.