

Faculty and Student Response to a Laptop Computer Requirement for Engineering Freshmen

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Introduction

Personal computers started to become common with the introduction of the IBM PC on August 12, 1981 [1]. Computing began the transition from large mainframes to desktops at that time. Desktop computers proved very useful for faculty and students, and “computer classrooms” were created at some universities, at great cost, and with significant recurring maintenance costs for both hardware and software. Some universities began requiring students, particularly engineering and computer science students, to purchase their own computers by the mid-1980s. Limitations for teaching were immediately noticed, and faculty began to imagine what could be accomplished if the students were able to bring their own computers to class. “Portable” computers such as the Tandy Radio Shack TRS-80 Model 100 [1] were not portable enough to be brought to the classroom.

There is considerable argument over when the first “laptop” computer appeared. Some of the early “portable” computers were definitely not laptop-sized or laptop weight. One of the first “notebook” computers may have been the NEC UltraLite [1, 2], which was introduced in 1989. These computers were still not sturdy enough to be transported to the classroom and were thus not required for students.

One of the earliest laptop computer requirements appears to have been at Wake Forest University in the Fall of 1995, when several hundred students and faculty began the use of IBM ThinkPad notebook computers [3]. A similar requirement was initiated at Rose Hulman Institute of Technology [4]. These experiments attracted national attention, and a university-level task force at Virginia Tech considered a laptop requirement at that time. However, the conclusion was that the price, performance, and lack of durability were such that the time was not right to initiate a laptop requirement at that time.

Virginia Tech PC Background

For several decades, first-year engineering students at Virginia Tech have entered as general engineering students, transferring to degree-granting departments after completing a prescribed set of courses. Beginning in 1984, entering engineering freshmen were required to purchase personal computers and selected software, which have been used as an integral part of freshman courses and in appropriate courses throughout the curriculum. A side effect of this requirement was that the College no longer maintains computer labs for undergraduates, since they own computers of sufficient capability for all of their course work. As the years passed, and the capabilities of personal computers increased, so did the minimum hardware requirement. One significant change was in 1994 when students were required to purchase computers that were “multimedia capable,” which opened new pathways for delivering instructional materials.

Beginning in 1999, there was a notable increase in the number of students who purchased laptop computers. As the number of students with laptops increased, several experiments were conducted where students with laptops were segregated into all-laptop sections of the first engineering course. Marked improvements in the teaching/learning environment were apparent, particularly the learning of engineering and math software, as what had previously been lectures on software became brief demonstrations followed by in-class exercises. The faculty role became that of assisting the students with problems. Students generally left the class with completed programming assignments.

Also since 1984, the College of Engineering has funded the SoftWare Assistance Team (SWAT Team), a group of students who assisted engineering students who were having hardware or software problems. SWAT Team members made “house calls” for students living in the dormitories. The cost of the SWAT Team increased over the years as the demand for students with computer repair and software assistance ability also increased, providing additional job opportunities, both on and off campus.

In 1999, faculty teaching the freshman engineering courses began to push for a laptop requirement. At that time, however, the reality was that laptops were still somewhat fragile, generally less powerful, more expensive to purchase, and more expensive and difficult to upgrade than desktop computers. The time was not right for a mandate, but there was strong indication that, at some point the advantages of laptops would outweigh their deficiencies.

In Spring 2001, five students enrolled in ISE 5694, Macroergonomics, advised by Dr. Tonya Smith-Jackson of ISE, conducted a well-planned and executed survey of 763 students in the second freshman engineering course regarding their opinions of laptops vs. desktops [5]. The questions involved gender, height (for considerations of carrying the computer across campus), computer experience level, average weekly computer usage, importance placed on initial cost, upgradability, worry of damage or theft, opinion of the possibility of enhanced learning, portability, ease of maintenance, faculty assistance, space requirements, use for notetaking, and several other considerations. Some of the results are shown in the graphs below.

Summary statements from the 2001 survey include:

- 93% of the students surveyed owned desktop computers
- 82% of the students surveyed were male
- 90% were over 5.5 feet tall
- 71% classified themselves as having “Intermediate” computer experience, and 23% as “Expert”
- 63% spent over ten hours per week using the computer for coursework
- 85% said the ability to upgrade the size of the hard drive was “somewhat important” – “important”
- 90% said the ability to increase the memory was “somewhat important” – “important”
- 50% said they would pay \$300-\$700 additional for a laptop
- 66% believed having a laptop would be “academically advantageous”
- Students were much more interested in taking their computer home for breaks as opposed to having portability around campus, and some thought the weight was too high to carry around

- 73% said the ability to receive faculty assistance with coursework (computer programs) was “somewhat important” – “important”
- 63% believed the primary advantage was for receiving computer software/programming instruction
- 51% believed the size of a laptop would be good, given crowded conditions in dorm rooms
- 85% were “strongly concerned” or “concerned” that their laptop would be stolen
- 81% were “strongly concerned” or “concerned” that their laptop would be damaged
- 80% were unconcerned about personal safety because of carrying such a valuable computer
- 8% of students would probably have gone to another school because of a laptop requirement

The survey also indicated that upper-class students were wasting a great deal of time traveling to and from campus multiple times daily so that they could use their desktop computers. (While first-year students are required to live on campus, two-thirds of Virginia Tech students live off-campus.)

As a result of the survey, discussions of a laptop requirement continued and expanded among the faculty and leadership of the College of Engineering. The primary factors against the requirement seemed to be overall cost, cost vs. performance, and lack of infrastructure (power and Ethernet ports in classrooms, suitable tables/desks in classrooms).

Implementation of the laptop requirement

During 2001, the decision was made that all new engineering students would be required to purchase laptops in the fall of 2002, and the plan was implemented in August 2002 without problems. In fact, this implementation coincided with the beginnings of wireless Ethernet access in the academic buildings, the Library, and the Student Centers, which resulted in the laptops being considerably more useful for overall student activities. We believe wireless access had a positive effect on the students’ acceptance of the new technology and this belief is supported by the increasing percentage of students who are using wireless Ethernet. At this time we have not tried large-scale use of wireless in the classroom because the campus networking group believes that such use would overwhelm the available bandwidth and bring the network to a halt, at least locally. It is only a matter of time until this minor problem is resolved. At that point testing by computer, with uploaded programs, files, minute papers, and so on will be routine.

As before, the software package included Matlab, AutoDesk Inventor, and MS Office. As was the case before, the freshman classes continued to be taught by the Division of Engineering Fundamentals (now the Department of Engineering Education) in 32-seat sections. A course coordinator provides all instructors a standard set of PowerPoint slides based on a common syllabus, with common homework assignments and common, common-time tests and final exam. Matlab and Inventor instruction, which had been taught in a lecture format, were switched to short lectures (approximately 10-15 minutes) followed by in-class exercises in which the faculty coach the students through an exercise. Typical exercises include implementing a user-defined function in Matlab and building a 3-D solid model of a relatively simple object in Inventor. Students are required to bring their laptops to classes of this type, which are approximately 40% of the class meetings and they have responded well to this method of presentation. This is not surprising, since our data indicate that 66% of our freshman students are “active” learners and

85% are “visual” learners [6] as measured by the Felder-Silverman model [7]. Most faculty enjoy the reduced lecture time because it allows them to have more interaction with the students, although this is stressful for those used to the comfort of being behind rather than in front of the podium.. This format was used for academic years 2002-03 and 2003-04.

At the end of Spring Semester in both 2003 and 2004, all students in the second engineering course were asked to complete an online survey designed to determine how the students felt their learning was affected by the use of laptops, their perception of the amount of use, and their overall opinion of laptop ownership. Approximately 650 responses were received in both surveys, and the results for the two years were similar.

The results for the spring 2003 and 2004 student surveys are summarized in Table 1. As can be seen, the students are overwhelmingly accepting of the laptop requirement. It is now quite common to see students in hallways, empty classrooms, or study areas using wireless and groups of students clustered around a table in the student center, with one or more laptops, working on a project. Although we have no firm data, our belief is that laptops have significantly increased student collaboration.

Overall, the students believed that the use of laptops had a positive effect on their learning of the material and that use of laptops in the classroom should have been increased. The vast majority reported that they were glad they had been required to purchase a laptop. Many cited the convenience of the laptop for group work. Students liked being able to take their computer to a teacher’s office for assistance, and the faculty agree. Very few (< 5) reported that their laptops were stolen, and very few reported dropping their laptop in a manner that resulted in damage to the machine.

Students having laptops has saved the College money. The budget for the SWAT Team labor has decreased from approximately \$15K Per year to \$7.2K per year since the beginning of the laptop requirement (even though hourly rates have increased from \$7.50 to \$10). A major portion of the savings can be attributed to the elimination of “house calls.” SWAT Team members no longer work in the dormitories, since students now bring their laptops to the SWAT Team office. Students also routinely bring their laptops to get assistance from faculty members and teaching assistants.

In Fall 2004, primarily due to the addition of Computer Science freshmen to the introductory courses, programming instruction was changed from Matlab to Alice based on an “objects first” approach [8, 9], and the role of laptop computers in the classroom became even more important. That work is reported in references 6 and 10.

As previously mentioned, after the personal computer requirement started in 1984, the College ceased to have significant computer laboratories for undergraduate students, only maintaining a small capability for students whose computers were not operational or for those courses that required software that students were not expected to purchase. With the beginning of the laptop requirement, especially coupled with wireless Ethernet, every room reached by the wireless signal can be a computer lab or a computer classroom. Since wireless Ethernet now covers

approximately 85% of the academic and administrative space at Virginia Tech [11], with additional increases of coverage planned, this capability will soon reach the entire campus.

Conclusions

- The basic conclusion is that the laptop requirement is a success.
- The laptop requirement has been well-received by students, who no longer worry about the same things they anticipated in 2001 (theft, damage).
- Students enjoy in-class work on software systems using their own computers. Files created during class are available for later review, reflection, and modification.
- Students believe their learning is enhanced by this mode of presentation
- We are somewhat surprised at the relatively small number of students who have opted to purchase external monitors.
- Students tend to take better care of their computers because they are required classroom tools.
- Students tend to take computer instruction more seriously since they are required to demonstrate proficiency as instructors walk around the classroom.
- Faculty like the new possibilities for learning environments that students' laptops enable
- Faculty also believe that student learning is enhanced.
- Costs to the College for maintenance of computer labs and costs to run the SWAT Team have decreased as a result of the laptop requirement.
- Every room on campus, and eventually the grounds, will become a computer lab or classroom.
- Current infrastructure may need to be upgraded. For example, the standard "one-armed" desks are not suitable for laptop use, and tables of some sort are required in the classroom. Power outlets distributed around the room may be required, although increased battery life has alleviated this requirement to an extent.

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Table 1. Summary of Student Laptop Surveys for Spring 2003 and 2004

Question/item	2003	2004	Comments
Purchased onsite warranty	74%	71%	This is something we encourage strongly
Computer required warranty work	33%	31%	Majority were satisfied with quality of service
Required assistance from SWAT Team	20%	17%	Majority were satisfied with quality of service
Have wireless Ethernet capability	82%	95%	Approximately 2/3 have used the wireless capability. Approximately half of those who do not have it plan to purchase it.
Purchased a mouse	79%	81%	
Purchased a full-size keyboard	21%	24%	
Purchased a docking station	13%	14%	
Purchased an external monitor	8%	5%	We expected this number to be larger
Satisfied with battery life	66%	75%	No surprise, since batteries improved markedly during that period
Laptop was stolen	3	1	Not a percentage, but rather the number who said their laptop was stolen
Laptop was dropped, causing significant damage	2%	1%	
Liked the in-class Matlab work	69%	63%	There was considerably more Matlab in the second year as we explored the uses of the laptops
Liked the in-class Inventor work	95%	92%	
Thought the amount of in-class computer work was "about right"	65%	62%	
Thought the amount of in-class computer work was "not enough"	20%	24%	
Thought the amount of in-class computer work was "not nearly enough"	5%	4%	
Thought the in-class computer work helped them learn the material	56%	57%	
Never checked e-mail, surfed the web, or used IM in class	55%	51%	
Did not find use of laptops by others in class distracting	65%	61%	
"All factors considered, I'm glad I have a laptop"	84%	90%	Most often cited reasons were portability, use for presentations, group work, overall convenience. Negative responses were due to cost.