Integrating Laptops into a Mathematics Curriculum

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In 1999, St. Mary's received a Title V Technology Grant, providing $2.1 million over five years. The money was used to help finance computers for students, fund faculty training for computer-related curriculum, convert traditional classrooms into technology or "Smart classrooms", and upgrade the school's Internet connections.

The first computers implemented in the program were Tangent Shuttle Pentium II 333 MHz MMX Notebooks. They came with Windows 98, Microsoft Office 2000, Eudora, Netscape, McAfee Virus Scan, and Secure CRT. Incoming freshman were required to purchase the laptops, adding an additional $571 to their tuition per semester. More recently the hardware has been updated to the Dell Latitude model C840, featuring Intel's mobile Pentium 4 processor, 15-inch video display, 512MB memory, 32MB video memory, 40GB hard drive, combination DVD, CD Read/Write Drive, and the Windows 2000 operating system.

Students can upgrade their laptop every two years. When they leave they can purchase the laptop for one dollar. Students receive training in orientation, ND101, and CS1300. Additionally, a Help Desk (questions) and a Service Desk (repairs) are available to address any problems they might have.

Faculty, depending on their expertise, is enrolled in one of three workshops. Workshop A, a beginning workshop, addresses Windows Basics, Email Essentials, Microsoft Word Basics, Power Point Basics, and Web Browsing and Internet Basics. Workshop B, an intermediate workshop, exposes faculty to Intermediate Windows, Introduction to Blackboard, Intermediate Word Processing, Intermediate Power Point, and Basic Spreadsheet in Excel. Finally, Workshop C, an advanced workshop, trains faculty in Video Design and Production using Pinnacle Studio 7, Graphic Design and Editing using Macromedia Fireworks 4, and Web Page Design using Dreamweaver.

The workshops are designed to take faculty at whatever level of computer expertise they might be at, and help them move through a hierarchy of more sophisticated stages, which include the following: (1) Entry – teachers struggle to cope with technology, (2) Adoption – teacher moves to successful use of technology at a basic level, (3) Adaptation – teacher discovers potential use of technology in a variety of applications, (4) Appropriation – teacher has mastery over technology and can use it to accomplish a variety of instructional goals, and (5) Invention – teacher develops new learning techniques that utilize technology as a flexible tool.

Grant money also helped St. Mary's update many of their classrooms to what are now called "Smart Classrooms." "Smart Classrooms" contain 24 to 40 notebook connections with electrical power and Internet access for students, and an instructor control panel, which manages a VCR, DVD player, overhead projector, document camera, notebook computer, and Internet connection. There is also a phone connection to the FIT Lab (Faculty Instructional Technology Lab) in case faculty experience technical problems. In addition to providing staff help, the FIT Lab contains hardware and software for faculty

instruction and research use. There are plans to construct sixteen "Smart Classrooms." Eleven have been completed to date.

St. Mary's also has what has become to be known as "Master Classrooms." Eight have been completed so far. Six only have a projector and faculty Internet connection. Two contain a faculty computer, projector, VCR, document camera, and Internet connection.

In the fall of 2000, eighteen courses campus-wide were identified as laptop sections. In particular, the Math department implemented laptops in two sections of MT 1411 – College Algebra and Trigonometry and one section of MT 2412 – Univariate Calculus I in the fall. In the spring of 2001, we expanded our laptop offerings to include two sections of MT 1411 – College Algebra and Trigonometry, two sections of MT 2412 – Univariate Calculus I, and one section of MT 2413 – Univariate Calculus II.

The Math department has experimented with a variety of software programs and activities in the laptop courses, including the following: (1) Mathcad – a software program for computation, graphing, and symbolic manipulation, (2) Blackboard – a software program that allows for the display of course content (information, documents, assignments, drop-box), the use of communication tools (discussion board, virtual chat), and the use of assessment features (create quizzes and tests, grade book, work in groups), (3) Web Activities (including demonstrations and simulations, practice quizzes), and
(4) Tutorials (including Journey Through Calculus and Thinkwell).

I slowly integrated the laptop into the mathematics classes, starting with the design of Mathcad activities. The next semester I began to post syllabi, homework assignments, class schedules, and old quizzes and tests in Blackboard. Finally, I designed multiple-choice questions for their use in Blackboard.

The following are a few examples of Mathcad activities that I designed for laptop use.

Sample Mathcad Activity

In Mathcad: Consider the function $f(x)=\dfrac{x^2-16}{x^2-5x+4}$

(a) Define the function.
(b) Graph the function.
(c) Evaluate the function at x = 3.9, 3.99, 3.999, 4.1, 4.01, and 4.001. Carry 6 decimal places.
(d) Use part c to guess the limit as x approaches 4.
(e) Use the symbolic evaluator to check your answer.

Sample Mathcad Activity

Use Mathcad to find the area of the region bound by the x-axis, the lines x = 0 and x = 2, and $f(x)=x^3+2x$

(a) Enter $f(x):=x^3+2x$

(b) Enter $R(n):=\sum_{i=1}^{n}\left(\frac{2}{n}\right)\cdot f\left(\frac{2\cdot i}{n}\right)$

(c) Find R (10). Use 6 decimal places.
(d) Find R (100). Use 6 decimal places.

(e) Find R (1000). Use 6 decimal places.

(f) Find $\lim_{n\to\infty} R(n)$

(g) Find $\int_0^2 (x^3 + 2x)dx$

(h) Compare f and g. Are they the same?

After implementing the laptop into my MT2412 – Univariate Calculus I classes for a year and a half, I felt as if it was time to gather some data on its successes and failures. I was interested in gathering data on students' preferred learning styles, previous technology experience, previous math experience, level of comfort with using technology, and use of laptops in other classes. In the fall of 2002, a survey was administered to fifteen male and fifteen female students. The survey included ten Biology majors, one Chemistry major, zero Computer Science majors, thirteen Engineering majors, zero Mathematics majors, zero Physics majors, and six classified as "other." The following includes a sampling of questions asked on the survey and the number responding in each category.

Learning Style

Which of the following best describes your preferred learning style for mathematical content:

a. read the material from the textbook (1)
b. listen to a traditional classroom lecture (26)
c. engage in a computer tutorial (3)

Learning Style

When I have difficulty on a mathematics problem I prefer to seek help by:

a. asking questions in class (13)
b. visiting the professor during office hours (2)
c. visiting the LAC during tutoring hours (10)
d. seeking on-line computer help (5)

Technology Experience

Which situation best describes your background:

a. I've never taken calculus before (in high school or college) (10)
b. I've taken calculus before and it was taught in a traditional manner without the use of graphing calculators and/or computers (3)
c. I've taken calculus before and a graphing calculator was integrated into the course (16)
d. I've taken calculus before and a computer was integrated into the course (0)
e. I've taken calculus before and a graphing calculator and a computer were integrated into the course (1)

Technology Experience

I own a:

a. TI 82, 83, or 83 plus (14)
b. TI 85, or 86 (8)
c. TI 89 or 92 (3)
d. Other brand (1)
e. Don't own a graphing calculator (4)

Technology Experience

In the mathematics' classes I took in high school, I used a graphing calculator in:

a. all of them (12)
b. some of them (16)
c. none of them (2)

Comfort with Technology

I would rate my knowledge of using a graphing calculator as:

a. excellent (1)
b. above average (9)
c. average (16)
d. below average (3)
e. very poor (1)

Comfort with Technology

I would rate my knowledge of using Mathcad as:

a. excellent (0)
b. above average (7)
c. average (18)
d. below average (4)
e. very poor (1)

Comfort with Technology

I would rate my knowledge of using Blackboard as:

a. excellent (6)
b. above average (12)
c. average (9)
d. below average (1)
e. very poor (2)

Learning Style

When solving a problem that called for the use of technology (routine graphing, routine computation, etc.), I preferred to use:

a. only the graphing calculator (1)
b. only Mathcad (4)
c. both the graphing calculator and Mathcad (25)

Learning Style

When doing a routine limit, derivative, or integral, I used the symbolic computation feature of Mathcad to check my answers:

a. never (0)
b. sometimes (19)
c. always (9)
d. didn't know I could check answers (2)

Learning Style

When studying for an exam I took advantage of sample tests at the Brooks Cole website:

a. never (17)
b. sometimes (3)
c. always (1)
d. didn't know this feature was available (9)

Use of Computers in Other Classes

Have you taken other laptop classes ?

no (6) yes (24)

If yes, how was the computer used?

a. used a software package (19)
b. used email (13)
c. accessed information from Internet (14)
d used Blackboard for:
    posting course information (16)
    on-line testing (10)
    group discussion (6)

An analysis of the data reveals that students continue to prefer a traditional classroom lecture to a computer tutorial delivery of the material. Students continue to seek out help to questions during class or at tutoring hours as opposed to going on-line for help. Over half of the students surveyed had previously taken Calculus I but had used graphing calculator technology in the course. Almost two-thirds of the class only rated their comfort with using Mathcad as average. On the other hand, two-thirds of the class rated their comfort level with Blackboard as excellent or above average. Finally, over eighty percent preferred to use both graphing calculators and laptops when solving a problem that called for the use of technology.

There appears to be many advantages to using laptop technology. Such advantages include the following: (1) enrollment is up, (2) classrooms received some much needed renovation, (3) the faculty is more computer literate, (4) there's technical support for computer instructional activities, (5) lap-top sections have reduced class size, and (6) students have generally reacted well to the lap-top program.

On the other hand, implementing the laptop program has also come with many disadvantages. They include the following: (1) need for additional security of classrooms, (2) poor configuration of classrooms undermined full use of technology, (3) faculty training focused too much on mechanics and not enough on pedagogical uses of technology, (4) students seemed reluctant to use Mathcad at first due to their previous experience and expertise with graphing calculators, (5) use of technology is time consuming, (6) need for additional lap-top sections led to staffing problems, (7) limited classroom space caused scheduling problems, and (8) release time for faculty training caused scheduling problems.