

PC Tablet



Project R.S Mitchell

(Reprinted from the PLT 2007-1st International Workshop on Pen-Based Learning Technologies-May 2007 Pre-proceedings. This material is posted here with permission of the IEEE. Such permission of the IEEE does not in any way imply IEEE endorsement of any of Innovation Showcase's products or services. Internal or personal use of this material is permitted. However, permission to reprint/republish this material for advertising or promotional purposes or for creating new collective works for resale or redistribution must be obtained from the IEEE by writing to pubs-permissions@ieee.org. By choosing to view this document, you agree to all provisions of the copyright laws protecting it.)

PC-TABLETS : *The Next Dimension*

Richard Mitchell

Humber College Institute of Technology and Advanced Learning

richard.mitchell@humber.ca

Abstract

For hundreds of years, Mathematics has traditionally been taught either on a piece of slate, a blackboard or more recently on an overhead transparency. Unfortunately, once the lesson is over, there is no permanent record of the event. Moreover, it is very difficult to make a **Black and White** medium exciting to a generation who grew up with Animation, Internet, BlackBerry and Bluetooth. Math instructors have tried to adapt lessons to the computer, but have had limited success simply because Math cannot be taught effectively in a Static Environment. For every example that is carefully designed and put onto a computer screen there exists the possibility that one may be asked for further clarification hence the permanent need for a blackboard. So, the challenge becomes how to incorporate all of the benefits that come with digital presentations, such as animation, audio, video and file transfer, with the capacity for spontaneous handwritten annotation.

That Innovation has finally arrived. Introducing the PC-Tablet...

1. Description of the Innovation

For over a year, a professor at Humber College, Canada, has not taught a single Mathematics lesson on the blackboard nor picked up a piece of chalk. Instead, he is piloting a project that uses a Motion 1400 Tablet PC and a projection screen to present his lessons. Based upon similar studies with other disciplines [1], the objective is to determine if Tablet Technology (TT) has any impact on Students and/or Professors within a College Level Mathematics Environment.

In general, Tablets give instructors both the power of a traditional lap-top computer plus the flexibility of an electronic blackboard. Using a variety of Tablet friendly software such as *EverNote*, *SketchUp* and *Math3.0*, Tablet PCs allow the

instructor to write, draw and record directly on the screen. He is now able to present exciting computer graphics and power-point slides, yet also spontaneously respond to student queries as they arise in class (see Figure 1).

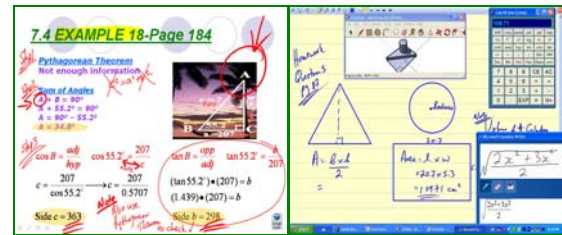


Figure 1: Sample Screens

Pen and ink integration allow for easy mark up, editing, annotations and graphics as explanations are now written and drawn directly on the computer screen. Not only is this professor able to prepare, save, print and e-mail lessons, but also modify, draw 3D geometric shapes and convert handwriting into text simply with a click of a pen. Less time is wasted on writing, drawing, copying and erasing while more time is allowed for quality explanation. In short, learning is more enjoyable and more efficient.

2. Participants

The Mathematics Department at Humber College is grouped into three categories: **General Mathematics**, **Business Mathematics** and **Technical Mathematics**. Courses range from basic numeracy to applied calculus, statistics and quantitative methods. Participants observed in this pilot project come from a variety of Applied Technology programs including architecture, logistics, electronics, chemical, civil and mechanical engineering. In order to measure the impact of TT upon these students, questionnaires, grades and anecdotal observations were gathered from three classes before and three similar classes after the Tablet was introduced into the classroom.

3. Impact of the Innovation

In this study, it was found that Tablet Technology (TT) impacted positively upon the *Quality of Learning, Attitudes* and *Grades* in technology based mathematics courses. More students at Humber College are passing and more students are getting higher grades simply because they enjoy the lessons and show up to class more often. Instead of the professor wasting time writing or erasing long equations on a blackboard, text is either already formatted or easily digitized onto a large projection screen. If the instructor needs to clarify or illustrate a variation, he simply writes over or adds additional text right on the Tablet screen in real time. This allows more time for quality explanation and less time wasted on copying since notes are also available on-line. If students are unable to attend, they simply download the missed lesson. As noted by the teacher, learning is not only more effective, but also much more enjoyable.

Teacher Based opinions, however, can sometimes be biased. So how do we measure and evaluate *Emerging Technologies*. This observer has turned to analyzing *Student Based* reactions. As shown in Figure 2, students confirm that grades, attendance and attitudes have changed significantly as a direct result of Tablet Technology. Evaluations often generate comments such as “Excellent, Amazing and Best Math Teacher Ever”.

Needless to say, the tablet projects have helped me to understand much better. I can see the lesson better. Especially, it saves time, so we have time for more examples. Even math class is at the end of the day, but I have to say. The tablet makes the lessons become interesting. As a result, I never get bored or tired. This course is one of my favorite

As I have expressed my opinion, I love the tablet technology. As a prospect of an international student, we pay too much to get study oversea, just for better education. Not only me, other students need it also. It helps teachers present their lesson better, and the students can understand clearly. And the class environment can improve also. I have

Dear Dean,
From my time enrolled in the TMAT 104 class IV found the use of the professor using the tablet project very useful and helpful to me. It has improved my grades and also my alertness in class. I find the tablet project necessary for the betterment of learning for all students not just at Humber College but all colleges and universities all over.

Figure 2: Student Comments

Anecdotal student comments, however, are somewhat limiting in determining the validity of introducing change into a classroom. As such, a more formal statistical approach was also adapted as shown in the next section.

4. Statistical Analysis

Every year the Ontario provincial government randomly surveys college students to determine their ‘satisfaction’ level with their learning. This Key Performance Indicator (KPI) survey [2] is used to measure how well Ontario Colleges meet the needs of students. Its purpose is to provide accountability information to government and to the colleges of Ontario. One of the questions asked is how satisfied students are with their mathematical skills. At the classroom level, instructors are also evaluated each semester by their students on their overall performance.

For purposes of this pilot project, one specific question was selected from the classroom survey and was used to compare differences between students who were taught using a traditional blackboard (*before group*) and those that were taught using Tablet Technology (*after group*). The task was for students to rank their *Overall Learning* in mathematics as either **E**-excellent, **S**-satisfactory, **US**-unsatisfactory or **P**-poor. A Likert Satisfaction Scale was used to measure this parameter. Scores were then converted into percentages (see Figure 3). Overall, there was an increase in the ‘Excellent’ category from 63.9% to 88.0% and a decrease in all of the other three categories indicating a more positive attitude toward their learning.

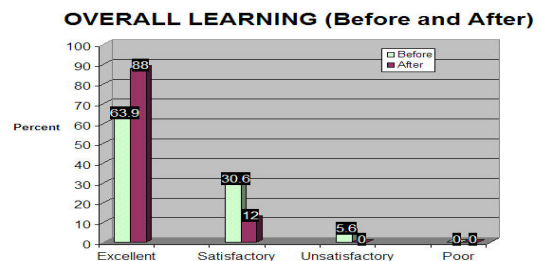


Figure 3: Student Evaluations (%)

As a follow up measure, a Two Sample t-test for means was used to see if overall differences were statistically significant (see Table 1). Using a 4-point ranked Likert Scale, it was determined that the original mean of 3.58 significantly increased to an overall 3.88* satisfaction level.

Table 1: Student Evaluations (Mean)

Student Questionnaire	Before (n=36)	After (n=50)
Overall, the learning experience was:	3.58	3.88*

Likert Rating Scale 4=Excellent, 3=Satisfactory, 2=Unsatisfactory, 1=Poor
*Indicates a statistically significant difference in means less than type 1 error
t-stat = -2.68, p value = 0.005

Moreover, a Population Proportion t-test also showed a statistically significant change in attitude specifically in the ‘Excellent’ category. In short, the response of ‘Excellent’ significantly increased while the categories of ‘Unsatisfactory’ and ‘Poor’ significantly decreased. Ironically, it could be said that as a result of the changed attitudes, the typically more common response of ‘Satisfactory’ also decreased.

A second parameter, Student Achievement, was also evaluated. Here, a Two Sample z-test for Means (see Table 2) showed a significant increase in Student Grades from 68.7% (before) to 74.0% (after)*.

Table 2: Student Grades (%)

Student Grades	Before (n=67)	After (n=80)
Final Grade	68.7%	74.0%*

*Indicates a statistically significant difference in means
z = -1.85, z Critical one-tail = 1.64

Upon further investigation, a Population Proportion t-test on Failure Rates showed no significant differences at the alpha=0.05 level despite the fact that rates did drop from 26.9% to 17.5%. However, significance was observed at the alpha=0.10 level. Although significance was low, the fact remains that more students are passing and more students are getting higher grades (see Figure 4).

GRADES vs FAILURE RATES (Before and After)

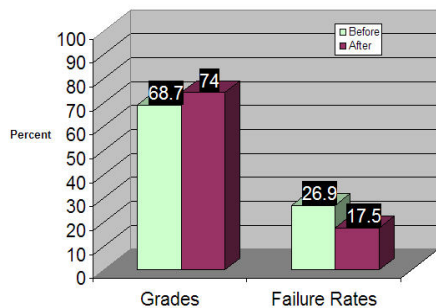


Figure 4: Grades vs Failure Rates (%)

As a final measurement, students in the *after* group were asked three Tablet specific questions on their student questionnaires. These questions compared the use of Tablet Technology to a more traditional Math class. Students were asked: (1) if **TT** made math more enjoyable, (2) if **TT** improved their understanding of math and (3) if **TT** should be used in more math classes. Students in all three classes (n=50) answered 100% ‘Excellent’ for all three questions indicating a total preference for Tablet Technology.

In summary, statistics are useful in identifying specific areas of change such as attendance, grades and failure rates. Sometimes parameters such as low scores, number of withdrawals and failure rates (**DWF**'s) are combined to specifically track ‘at risk’ students [3]. In any case, future statistical interpretations must recognize the limitations of anecdotal records and strive to improve the size, type and quality of data analyzed.

In addition, the question of change itself should also be addressed. What was it specifically about the Tablet PC that improved student attitudes and grades so much? How much change resulted from the instructor’s enthusiasm and how much change resulted from simply being able to better read the instructor’s notes? A variety of parameters will be investigated in future studies but the fact remains that students did enjoy the Tablet experience and their overall satisfaction with this style of teaching did significantly improve.

5. Scope of the Innovation

Presently, at the time of publication, there is only one pilot project and only one Math professor at Humber College evaluating Tablet Technology in the classroom. However, as a direct result of presentations given last year, several Math colleagues at Humber are now on a waiting list for a Tablet PC. Moreover, several Math professors at other local colleges are also starting to introduce **Pen-Based Learning Technology (PBLT)** into their classrooms.

Obviously, the concern is not with hardware since Tablets are easy to find at your local electronics outlet. The real challenge is how to incorporate Tablet features into an appropriate **Learning Model**. First, we should determine what we want students to be able to do and experience in their learning, then we can select the right technologies [4]. In this pilot project, it was demonstrated that professors of Mathematics can easily and effectively adapt this technology into their classroom. The difference with Tablets is that we drive the technology rather than the technology driving us.

6. Disadvantages

In any technologically based project there are common problems and difficulties such as equipment, time, scheduling and training [5]. In this project, the concerns were: (a) Hardware, (b) Software, (c) Support and (d) Ergonomics. At first, there was a long learning curve since support

structures were not yet in place. Technicalities such as video output and WiFi security turned into major obstacles. Wasted time was also spent evaluating a variety of inappropriate software. Obviously, it is strongly recommended that good support structures be in place. In addition, a most unexpected problem arose while using the Tablet on a traditional computer/lecture podium. These platforms were originally designed for lap-top and desk-top computers. The typically hunched over writing position needed for a Tablet was stressful at first on the neck and back. This stress was overcome, however, by a combination of sitting and standing.

7. Implications for the Future

In the opening remarks, the question asked was how to present Mathematics effectively in a college-level learning environment without using a blackboard. The solution was to adapt a Tablet PC wired to a projection screen. In this pilot project, it was demonstrated that the advantages of a digital format can in fact be combined with the need for traditional writing and drawing, thus making Tablets the ultimate presentation tool in the classroom.

Tablets were also shown to have a positive impact upon the *Quality of Learning, Attitudes Toward the Learning Process and Improvement of Grades*. Both the instructor and students experienced a significantly more enjoyable and much more satisfying learning environment.

However, one theme yet to be addressed is the future of *Pen-Based Learning Technologies (PBLT's)*. How long will they survive; who will use them next; or are they just one Click Away from last year's news? Tablets have excellent speech recognition, mobility, screen rotation and handwriting features making them particularly adaptable to Special Needs applications. In addition, Tablets also have *State of the Art* Wireless and Bluetooth features that make them versatile for administrative, faculty or support staff use. Moreover, classroom systems exist today that allow for Web-Based Interactive Collaboration [6], Distant Education and Wireless Instruction from anywhere in the world.

So, as much as this pilot project may have changed the way that Math may now be taught at Humber College, this Innovation has only just begun to take shape. As other institutions and disciplines adapt the handwriting/shape recognition ability and begin to explore Wireless Mobility and Speech Recognition, the very concept of the *Four-Walls-Blackboard-Teacher* could become obsolete.

Imagine the *NEXT DIMENSION* of Mathematics. Students are seated outside on the grass as they interact in real-time using wireless touch screen *Ultra Mobile Personal Computers (UMPC's)*. International students are also on-line using universal speech translation software. As the lesson begins, the facilitator addresses the main screen. Everyone sees the same image on their touch screen Tablets. Soon afterwards, one student is given control and starts to sketch a 3-D geometric shape with his pen. Then another joins in and shares his ideas on the same screen. Each, in turn, contributes their ideas to the *Field of Dreams*.

Imagine a class with No boards, No walls and No boundaries...

8. References

- [1] Berque, D.A., Prey, J.C., and Reed, R.H. (eds.) *The Impact of Tablet PCs and Pen-based Technology on Education*. Purdue University Press, West Lafayette, 2006.
- [2] <http://saskgradsurveysproject.net/surveys/OnCollegesKpiSurveyDescription.pdf>
- [3] Reba, M. and Weaver, B. Tablet PC-Enabled Active Learning in Mathematics : A First Study. *Proceedings of the 1st International Workshop on Pen-Based Learning Technologies-Enabling Advanced Graphical, Multimodal and Mobile Learning Interactions (PLT 2007)*, May 2007, 68-73.
- [4] Amirian, Susan. "Putting Tablet PCs to the Test. (Column)." *THE Journal (Technological Horizons in Education)* 32.4 (Nov 2004): 28(2).
- [5] Bauer, John, and Jeffrey Kenton. "Toward Technology Integration in The Schools: Why It Isn't Happening." *Journal of Technology and Teacher Education* 13.4 (Winter 2005): 519(28).
- [6] Pargas, R.P. Seeing Clearly Through Ink in Computer Science Courses. *Proceedings of the 1st International Workshop on Pen-Based Learning Technologies-Enabling Advanced Graphical, Multimodal and Mobile Learning Interactions (PLT 2007)*, May 2007, 13-19.