

**Tablet PC Use at Northern Lights Public School:  
A Follow-up Evaluation**



**York University Institute for Research  
on Learning Technologies**

**Technical Report 2006-3**

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## Overview

This report describes a study of Tablet PC use in grade 6 at Northern Lights Public School in spring 2006. It follows up on an evaluation we carried out the previous school year with grade 8 student use of Tablet PCs in the same school. In preparing this report, we observed in the two grade 6 classrooms as teachers taught two projects using Tablet PCs. In addition, we interviewed the teachers and held group discussions with students on their opinions about the Tablet PCs at the end of the project.

Observations over the first of the two projects found that students enjoyed working with the Tablet PCs, and generally employed them in task-appropriate and educationally sound ways to develop concept maps using a mapping tool and then used those maps to scaffold the composition of an essay. Teachers were not familiar with the unique features of Tablet PCs such as the stylus, so they were not taught to students nor did students know how to use them. As a result we suggested that a professional development session be held for the teachers to help them to learn to use these features and how they could be employed in teaching. The session took place but the focus was only on the technical operation of the Tablet PCs. Nevertheless, the teachers came up with their own ideas on a second round of projects that they taught using the unique features, one using Tablet PCs for Geometer's Sketchpad, the other for conducting a survey. In these projects students did make use of a subset of the Tablet PCs unique capabilities, primarily by using the stylus for operating the tablet, inputting text, and creating diagrams. During both sets of projects teachers spent from 30-50% of class time dealing with technical such as logging in, finding and saving files, and printing over the wireless network.

Overall, teachers did not feel that Tablet PCs added value over regular laptop computers to the student's learning given their limited knowledge of Tablet PCs. The trail did have some benefit, however, as it pointed out areas that need to be strengthened if Tablet PCs are to be used successfully in elementary classrooms. We provided six recommendations to accomplish this as follows:

1. Implement improvements in network architectures that allow rapid and reliable access to programs, files, and folders, even under heavy load conditions.

2. Provide teachers with meaningful opportunities for professional development related to Tablet PC use.
3. Provide teachers with ongoing support for integrating Tablet PCs into their curricula.
4. Provide teachers with resources to assist them in integrating Tablet PCs into their teaching.
5. Improve the quality and timeliness of technical support for Tablet PCs.

Assign the Tablet PC set to one (or at most two) classes for a full year.

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by  
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## **Background**

This report presents the findings of a small-scale evaluation of the Northern Lights Tablet PC pilot project conducted by the Institute for Research on Learning Technologies at York University, which serves as a follow-up to an earlier evaluation completed in 2004. At the start of the pilot project, Acer TravelMate C110 Tablet PCs loaded with Windows XP Tablet PC Edition and Microsoft Office as well as several other software titles were provided to all Northern Lights Public School teaching staff in September 2003 and to every grade eight student in December 2004 for their individual use (including home use) over the remainder of the school year. The initial evaluation of the Tablet PCs' use was conducted in the spring of 2004. Researchers observed student usage; surveyed students, teachers, and parents; and interviewed grade 8 teachers, students, and the principal. The overall goal of this evaluation was to determine the impact that this use had on teaching practices, student learning, and other teacher and student outcomes over the year.

This earlier study concluded that that the project was as successful as one might have reasonably expected given the short period of time the project was fully operational, the lack of teacher support provided, and the technical difficulties encountered. Teachers in all grades made regular use of the Tablet PCs to perform a variety of functions, including email, lesson planning, student record keeping, communicating with parents, and doing more interactive activities than in the past with students. The grade eight homeroom teacher, whose students had their own personal tablet, found that the Tablet PC supported his project-oriented pedagogical approach well. The other two teachers also saw the potential of the Tablet PCs to support student work in their subject areas, although they did not make as extensive use of them with their students. Grade 8 students became more motivated toward their schoolwork as a result of having their own personal Tablet PC, despite occasional technical problems that caused lost work and frozen

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machines. Teachers and students alike, with a few exceptions, felt that the quality of student work and possibly some grades had improved.

However, there were clear limitations in the uses made of Tablet PCs at the school which reduced the potential for its positive impact on students. Neither most students nor teachers learned about and/or made significant use of some of the more advanced functions of the Tablet PCs such as handwriting recognition. And the lack of teacher support for technical, pedagogical, or planning and preparation for using tablets severely constrained the innovative use of tablet functionality in both teaching and student learning activities. Network capacity and reliability regularly caused operational problems.

The report made several recommendations for action by Microsoft (one of the project's sponsors), the school, and school board, including that (1) teachers need be given technical training on how to use all features of the tablet; (2) teachers need to be provided with ongoing pedagogical support for integrating Tablet PCs into their curricula; (3) consideration should be given to mounting a late August voluntary professional development institute for teachers to launch both recommendations 1 and 2; (4) teachers need to be provided with resources to assist them in integrated Tablet PCs into their teaching; (5) the Tablet PC synchronize function needed to be thoroughly tested in actual classroom settings to identify and correct any technical difficulties; (6) increased technical support to Northern Lights should be provided; and (9) the formal evaluation of the project should continue the following year, employing a year-long research strategy.

Plans were made and funding obtained for a smaller-scale follow-up evaluation of Tablet PC use in the next school year (2004-2005), to be conducted subsequent to a planned implementation of teacher professional development that would address recommendations 1 and 2 above. The suggested Summer Institute was not conducted, but a one-day training session in the operation of the Tablet PCs (including stylus use with OneNote, a tablet-enabled multimedia document creation application) was attended by a few Northern Lights teachers (as well as staff from a few other schools). Unfortunately it was not held until the beginning of April 2005, at which point it was felt that given the limited amount of time that teachers would have to make use of what they had learned at the session over the remainder of the school year, the best course of action would be to postpone the follow-up evaluation until the following school year.

The following fall, a decision was made in conjunction with the school to shift the focus of study to grade six students as these students (and their teachers) were to be using laptops and Tablet PCs regularly as part of their participation in the Wireless Writing Project, a board-level initiative studying the impact of

wireless laptop use on student writing. One focus of the tablet evaluation was to examine what (if any) added value Tablet PCs brought to the student writing process. However neither of the two grade six homeroom teachers had attended the Tablet PC professional development session the previous year, although they had been using their own Tablet PCs for two years.

In the interim the school administration had abandoned their initial dedicated-use model of Tablet PC assignment in which an individual student had exclusive use of a tablet for the entire school year (including home use). The tablets were now deployed in the same manner as the laptops at the school: a class set was placed in a portable charging cart that any teacher could sign out for a period or two. As a result, grade six students during the 2005-2006 school year were only using the tablets on average every week or two for a double period (about two hours), and were not able to take the tablets home at all. They also made occasional use of Dell and Apple laptops. (A few students in each grade six class who were on Individual Educational Programs had their own dedicated laptops that stayed with them all day.) It was in this context that the Tablet PC evaluation was planned for the 2005-2006 school year.

## **Evaluation Objectives and Methods**

The follow-up evaluation was designed to investigate how teachers employed Tablet PCs in their teaching, how and to what extent students made use of the different capabilities of the tablets, and the effects of tablet use on student motivation, attitudes, and learning. To compensate for the very occasional access to Tablet PCs that the grade six students typically had in the course of their everyday schooling, which would not provide a very meaningful basis for study, it was agreed that both of the grade six homeroom teachers would develop short student projects in subject areas of their choice in which Tablet PCs would be used extensively, and that these projects would be the focus of the evaluation.

Qualitative research techniques were used to study this project work, delineate student and teacher attitudes and perspectives on tablet use, and investigate its impacts. All classroom time devoted to two short projects undertaken in each class was observed in order to gather data on teacher practices, tablet use, and student work processes. The first pair of projects were undertaken in February, the second in April. Shortly after the conclusion of the April projects, two focus groups of approximately four students each were interviewed from each of the two classes to gather their perspectives on tablet use, its advantages and disadvantages, motivational impacts, and perceived effects on their project work. Both teachers were individually interviewed in the same time period to gather

data on their background and extant technology proficiencies, assess their understandings of the educational affordances and limitations of tablet use in the classroom and the outcomes of their tablet project work, and tap their perceptions of the tablet-based projects on student achievement and motivation. Samples of student project work were also collected for review.

At the suggestion of the research team, about a month after the teachers' completion of their first class Tablet PC projects, a half-day professional development session on Tablet PC use was conducted for them by a board resource teacher. The professional development session was recommended because observations over the course of the first student projects indicated that the Tablet PCs were being used solely as laptops—in fact the tablets were not even equipped with styli and so tablet-specific features and affordances were inaccessible to students. It was hoped that this session would provide the teachers with the operational skills needed to use the unique tablet features with their students, as well as ideas and plans for classroom projects that would exploit the tablet's affordances in an educationally significant manner. The professional development session was observed, and its content as well as its impact on teacher skill and on the April student projects analyzed.

## **Evaluation Findings**

### *Teacher and class background*

The two grade six teachers<sup>2</sup> participating in the study, both males in their late thirties, had both taught for several years at the junior level. One teacher, Bill, had a full grade six homeroom class in the 05/06 school year; the other, Jeremy, had a split grade 5/6 class. Each had had their own Tablet PC since December 2003, and made regular use of them for searching out curriculum materials on the Web, emailing parents, creating PowerPoint presentations for teaching, and recording student assessments. Jeremy also used his tablet to develop lesson plans. Bill used Excel for keeping track of student grades and had taught with Excel but had not used databases; Jeremy had taught using Excel and database software, but “rarely”. In their interviews (which were conducted well after the half-day tablet professional development session) both indicated that they were “very comfortable” with using the stylus for writing on the Tablet PCs and working with both OneNote and Windows Journal, two of Microsoft's tablet-enabled

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<sup>2</sup> Pseudonyms are used for the teachers.



document creation programs that both teachers and students had access to on the tablets.

Both were comfortable with having their students use laptops (including the Tablet PCs) in their classrooms, and students made occasional use of them for expository and creative writing in Language Arts and other subjects, creating a few PowerPoint presentations for projects and presenting these to the class, researching projects via Google searches, and (more rarely) using multimedia software such as Photoshop and Movie Maker or tutorial software. Bill had his students use Microsoft Publisher to create thank-you cards for a student teacher and a Christmas book; Jeremy had his students use the same program to create brochures for drug education, and Movie Maker to build multimedia Mother's Day cards. Bill's students reported using Excel to create graphs, and very occasional use of some Web-based math tutorial software provided by the school board. For both classes, Word was the primary application used for writing; according to students, OneNote and Windows Journal received little use outside of the observed project work. (Journal was used a few times in Jeremy's class to create diagrams.) Students would frequently use a cut/paste/reword procedure when creating essays or projects in Word or PowerPoint from Web-based sources.

With the exception of the April project activities, Tablet PCs were always used in "laptop mode", which is to say with their keyboards and touch pads as their only input devices, as if they were ordinary laptops. In fact, the teachers indicated that the tablet styli had been removed and stored at the start of the year "to prevent loss", and when it came time to find them for use in the observed projects locating them took considerable effort.

Both classes in the study had about 28 students, about 80% of whom appeared to be Caucasian. There were a few black and Asian students in both classes as well. Each class had a roughly equal gender split, and Jeremy's class had approximately the same number of students in grades five and six.

### ***Teaching and Learning with Tablet PCs: Student Projects***

*February projects.* For their initial class projects, both teachers decided to make use of concept mapping software licensed by the school board called Smart Ideas. The software enables student construction of concept maps by assembling a range of pre-drawn shapes and lines into concept diagrams, and then entering text labels and content associated with these elements. Submaps and other content could be nested within shapes by double-clicking in side the shapes. While Jeremy had already made some initial use of Smart Ideas with his students by this point in the year, Bill's class was new to the software. The two classes were

brought together in a common area to receive instruction in the use of Smart Ideas from Jeremy, who worked with a SmartBoard connected to a laptop to demonstrate the various elements and functions of the program students needed to use to construct simple multi-leveled concept maps. He discussed the components used in the diagrams, how they related to the ideas the students would represent, and how these components were to be connected to create a representation of the knowledge relations in the web of ideas that were being mapped. He had students think of some character qualities of Homer Simpson which he then mapped off a central icon representing Homer, and then had them come up with supporting facts that provide evidence for these characteristics. He then demonstrated how to click on a character trait box to open it up for entry of these proofs at a secondary level. The students seemed to grasp these operations readily enough and could demonstrate the steps when asked to by the teacher.

Following about 20 minutes of training the two classes returned to their respective homerooms, and Jeremy explained to his class the nature of the project students were to work on: they were to develop a list of four character traits of Tuck (a main character in a novel the class had read) and develop a minimum of three supporting proofs for each character trait, as evidenced in the novel. These were to be entered into concept map and the map would then serve as the basis for constructing a persuasive essay on the character's traits. Jeremy worked through an example of one trait and its proofs (calling on students to provide the latter) and showed how these were to be diagrammed in the software using a SmartBoard. He reviewed and demonstrated how the created diagrams were to be saved on the server in students' folder areas. Twenty-two tablets were distributed (6 students were selected by him to double up due to the lack of a full class set), and students began to log in to the server over the wireless network and download Smart Ideas from the server, a process that took about 10 minutes before most of the class had access to the program. A handful students could not access the folder with the program; Jeremy helped them, but had some trouble in several cases, eventually discovering that he needed to use a different user ID than the students' one of record to gain access. Over the course of the double period, about one third of Jeremy's time was devoted to dealing with technical issues, primarily difficulties students had in accessing the program, saving files, and printing their diagrams.

Most students were able to start creating their maps autonomously, but a few needed the teacher's help in operating the program and getting it to create, place, label, and/or link the elements of the maps. Jeremy would typically either provide verbal instructions which the student would follow or take over the keyboard himself and take the steps needed to produce the desired result. Students

rarely showed signs of not conceptually understanding how to do the mapping; rather the challenges for a few lay in making the software do what they wanted it to do. The maps created evinced considerable creativity and customization in terms of the types and colours of the shapes and links used, and the formatting of the text—for example, one boy proudly showed peers how he had used graduated shading in his oval shapes. Students in general worked diligently and most talk in the room was on-task as students compared their diagrams and discussed character trait choices and proofs.

None of the students used the Tablet PCs in tablet mode at any point in this project—as mentioned earlier, they did not even have access to the styli needed to do so. Input was by keyboard and touchpad only.

Project work continued over a few periods in the next few days. In a later class Jeremy again demonstrated the nature of the proofs needed to support character traits through a process of interactive question and answer work with his class, and then had the students work with him in constructing a simple persuasive essay based on a completed character trait concept map that the class built together. Students were then told to print out their concept webs when completed for later grading, and to use Word to type up their essay drafts guided by their map. Jeremy reminded them to save and then print their essays, reviewing how to do this, and then told them to have a peer edit their onscreen copy before printing. Logging in and downloading files and software from the network continued to be time consuming process that required an inordinate amount of teacher attention. A Special Education Resource Teacher (SERT), Tom, who was considered a technology expert in the school, was present through most of the project work periods, and his time was largely spent helping students deal with their technical issues around logging in, saving, and printing. While students waited for logins to work or program loading to complete they typically engaged in considerable off-task talk.

After approximately two hours of project working time, about half of the students had started their essays; the other half were still completing their concept maps. Throughout this period there were anywhere from three to six students lined up with their Tablet PCs waiting to get help from Jeremy at his desk, most with technical issues, a few wanting to have their essay work reviewed. Most students were able to build essays with all the required elements (introductory sentence, a paragraph on each character trait with proofs, concluding sentence) with no assistance but a few needed guidance from one of the teachers. Jeremy was able to get away from his desk occasionally to monitor student work and make recommendations. He had to remind the group a few times that their essays

need to be peer edited before handing for grading. Students appeared to have no difficulty in using Word to create and format their essays.

After the student project work was finished and had been reviewed by Jeremy, he remarked to a researcher that he found the quality of the work generally good, with reasonable character traits and proofs being included in the essays, and most essays having the required elements in proper sequence. Nearly all students had completed their essays in the allotted class time but a few had to complete them out of class.

The other grade six teacher, Bill, had his students undertake a science project once they had received their training in Smart Ideas from Jeremy. He had earlier distributed to the class a 3 page project worksheet entitled “Animal Research” that had been taken from a curriculum resource binder. He reviewed his expectations for the project with the class; these expectations were a subset of those listed on the worksheet. Students were to select a vertebrate animal and then develop a list of five categories that describe this animal and its life based on their earlier work on animal life in science. For each category (e.g. habitat, food) they were to briefly describe its characteristics for their animal. (There were areas on the worksheet for writing this information down). Students were then to map these characteristics out using the Smart Ideas software. The teacher described the way the map was to look, with the animal name in the central position, surrounded and linked to boxes for the five categories, and the category particulars for the animal nested inside the boxes (the nested level was to be reached by double-clicking in the box). The teacher, with the assistance of Tom (the SERT), then handed out the Tablet PCs (which had to be supplemented with several laptops as there were not enough working tablets for the full class to use), and students began logging into the network and loading the programs they needed to use. During this ten minute long process most of the two teachers’ time was devoted to assisting those having difficulties with startup and program access. As with Jeremy’s class, no use was made of the Tablet PC stylus over the course of the project by any student as the tablets were not equipped with them.

Students had started their animal research in an earlier class, and some quickly defined their categories for their concept map based on this research, which they then continued to work on; others had not done any research to date, and so started to research the animals they chose. Research was conducted primarily via Google web searches for text and pictures; in a few instances books from the school library were used. As the double period progressed, a few students gradually finished their research (usually making notes on their worksheets) and then started up Smart Ideas and began building their concept maps. Some students needed teacher help to find and load the program. Bill circulated through the

class, checking that students were using the right layout for their maps and the right categories for the properties of interest. When he saw that many were off course in their category choices he diagrammed the map on the board, showing the categories they should be using—habitat, food, predators, reproduction. (Some students had created category boxes that were not labeled with the abstract term for the category (e.g. “habitat”) but rather with descriptions of the category’s properties for their animal (“tropical jungle”). Students had no operational difficulties however in creating their concept maps with the software.

Students continued to work on their research and concept mapping in a second double period a few days later. Once again there were a number of technical difficulties in accessing Smart Ideas on the tablets: Tom told Bill how to type a DOS pathname that would open the program directory and the two teachers spent about the first 15 minutes of the period getting students access to the program. Bill reviewed with the whole group how data can be entered at the nested level of a category on the concept map.

Bill spent about two thirds of the period monitoring and assisting students as they worked at their desks. The most common type of assistance given was aid in resolving difficulties students had in getting the software to do what they wanted it to. For example, he assisted one boy who had created one box on his chart representing one of the categories about his animal that he could not double click into to enter the nested level for inputting text, nor could he link the box to other boxes on his map using arrowed lines. Bill took over his keyboard and quietly tried a few things but was unsuccessful at solving the problem at first. Finally by deleting a pre-existing connector in the diagram he is able to resolve the issue, but he states that he is not sure why that worked. From his work with students it became clear that Bill was to some extent feeling his way with this software and had had limited prior experience with it.

Less frequently Bill would guide and scaffold students who had trouble developing their animal categories and/or the animal characteristics for those categories. When a girl could not come up with adaptations for her animal of choice (the cheetah) and sought help, he used leading questions to guide her to an understanding of what adaptation is and the kinds of information about animal characteristics she needed to collect. She then started researching these on a Web-based cheetah fact sheet.

A few times students were observed helping each other resolve operational issues with Smart Ideas. While most students were relatively comfortable with it, a few found it challenging and sought help from more skilled peers.

Towards the end of the double period Bill told the students that this was their last period for class work on their maps and that they should be saving and printing them out before the end of class. About one half of the students had filled out their worksheets with animal data; the rest have chosen to take what they have read on Web sites and either cut-and-paste it into the concept map boxes or (more frequently) directly key that information into the map in their own words.

By the end of the double period most students had completed and printed their maps. Bill had to spend considerable time helping students save and print their documents. (Tom had left the class after the first hour.) He was satisfied with most students' concept maps, and planned to have students use them in a later class as the basis for writing a short expository essay on their animal of choice and its characteristics.

Bill commented after this class that he was not at all comfortable with tablet functionality and had not had any training on it, and that he had never had his students use the Tablet PCs in tablet mode.

*Teacher professional development session.* As mentioned earlier, the complete lack of use of the unique tablet functionalities by teachers and students in the February projects led the researchers to encourage the school administration to provide Bill and Jeremy with a professional development session on the Tablet PCs to develop their knowledge of and facility with the tablet's unique capabilities, with the aim of better preparing them to use these in their teaching and to help their students take advantage of them in their work. It was suggested that the session also present the teachers with plans for student projects that were designed to utilize the tablet's unique functions in ways that facilitated the achievement of the teachers' curricular goals and pedagogical objectives.

The school agreed to provide such a session, and it was held over half a day in early March, with Bill, Jeremy, and the school's vice-principal in attendance. The session was led by the computer resource teacher for the local family of schools (Carl). He talked about and demonstrated via video projector a range of tablet-unique functions, including stylus-based navigation and text entry, and script-to-text conversion. He also demonstrated some of the features and operational capabilities of OneNote software (document creation software specifically developed by Microsoft to take advantage of tablet and stylus functionality). The teachers tried out these operations on their own tablets in tandem with the demonstrations. Carl also showed some templates for OneNote that had been designed for education by Microsoft; for example one included templates for different types of organizational and flow charts for mapping reasoning trees. Carl was not able to answer a few operational questions on

OneNote and the Tablet operations in general that the teachers posed, and had to fall back on a trial-and-error approach to finding solutions which was not always successful. Carl discussed the use of the tablet as a teacher assessment tool for creating running records, and using rubric forms downloaded from the Ministry and the Board. He noted that rubrics could be downloaded to students who could then reference them as they wrote essays to highlight the areas in the essay that individual rubric levels applied to when they did a self-assessment. The use of searchable note flags in OneNote that can be assigned different meanings by teachers was discussed.

Carl did not present any plans or articulate any concrete ideas for curriculum-embedded student projects tied to the grade six curriculum that made potentially significant use of Tablet PC functionalities, nor did he illustrate in any substantive way any possible educational “added value” that tablet use might have for students. By the end of the session, Bill and Jeremy had a better understanding of tablet functions but still had no clear ideas as to how students could most effectively leverage these functionalities in their learning, and had formulated no project plans beyond expressing some very general ideas for project topics. But the teachers agreed to develop and implement short projects in which students would use the Tablet PCs in tablet mode, projects which the evaluation team could observe.

*April projects.* Jeremy decided to involve his students in a polling project, in which the tablets would be used with a stylus to create a tally sheet for the poll and to collect poll responses from students in other classes.

Prior to starting the project, Jeremy provided about half an hour of Tablet PC instruction to each of three groups of eight students just outside the classroom in a pod area, demonstrating the use of the stylus and the operations needed to create documents in Journal. Students practiced these operations on Tablet PCs, and these students then were used to provide peer training for the remaining students, a process which Jeremy indicated had worked very well. Jeremy acknowledged that OneNote made greater use of the tablet’s capabilities than Journal but he had decided to have students work with Journal for their projects because it resided on the tablets’ hard drives, whereas OneNote had to be downloaded from the server, a process which could take ten to fifteen minutes to get the class to complete.

He introduced the project to his class by describing the tasks the students would need to complete: determining a question and the answer choices for the survey, creating the survey tally sheet using the stylus in Windows Journal, conducting the survey in three other classes using the tablet, analyzing the data,

entering the data into and generating a graph in Excel, and integrating that graph and the tally sheet into a survey report written in Word. He described what the tally sheet would need to do, and told students to have two columns for the responses—one for boys and one for girls. He then generated an example tally sheet on the board for a question asking a respondent to select their favourite NHL team from a list, and told students they would need to select what type of chart to use to best represent the data (students had created charts in Excel before). Students were told they would be provided with instruction sheets outlining the procedures needed to create graphs in Excel, and were asked to choose partners to work with as there were not enough working Tablet PCs for everyone in the room.

Students then spent about ten minutes selecting partners and developing a polling question and answer options. They were then allowed to get a Tablet PC and begin developing a tally sheet in Journal. The teacher (with the assistance of a teacher candidate who was in the room) distributed styli to those with tablets. Students were able to quickly load Journal and begin the process of drawing and scripting their tally forms using the styli, with the Tablet PCs folded into their keyboard-less slate layout.

Students appeared to have no difficulty using the styli to draw their tally forms, and did so fairly quickly. A few used rulers placed on their screens to draw straight lines for the borders and boxes on their form, but most generated it freehand. Jeremy instructed the class to use a different colored pen ink for putting on the tick marks when they conduct their survey using the tablets with the stylus, so that the marks stand out on the form.

Students chose a range of topics for their surveys, ranging from “favourite ice cream flavour” to “preferred gaming platform”. The teacher told those finishing their forms that they could not go to the neighbouring class to collect data until everyone was ready to do so, so early completers began to survey each other. Jeremy then talked briefly to the class about sampling and asked who and how many should be surveyed in the other classes. “Do you want to survey just your friends? Why or why not?” A short discussion of bias in data collection ensued.

When the forms were finished students took their tablets into each of three neighbouring classrooms in turn, spending about seven or eight minutes in each class, having students respond to their survey and checking off responses on their tally forms.

Student motivation was high throughout these stages of their project work. They were consistently focused on completing their forms and gathering



responses and it was very clear from observation that they were enjoying the process a great deal. This was also commented upon by Jeremy.

Upon returning to class, students were told to save their Journal files. The following day Jeremy used a scaffolded questioning technique to elicit from students the steps they needed to take to tally up their data and enter them into an Excel spreadsheet. Students were then to copy over the tally sheet from Journal and the chart from Excel into a Word document and write up summary of the results in the same document, presenting three conclusions. A sheet was distributed that provided instructions in graphing Excel data. It is worth noting that Jeremy did not show students how to convert their handwritten tallies in Journal into text that could then be copied and pasted into the spreadsheet; students simply typed in the totals for each category for male and female respondents into the spreadsheet.

When students retrieved the Tablet PCs about half chose to work with them in laptop configuration with the keyboard; the others used the stylus. Once their tallying was complete they all switched over to laptop mode to enter the spreadsheet data with the keyboard. They did however use the stylus to lasso their tally sheets in Journal in order to copy them over to their Word project report.

Some pairs of students quickly totaled their tallies and then started logging in to access Excel and Word via the network. As usual logging in took ten to fifteen minutes for everyone to complete, and some students engaged in off-task talk while they waited. Jeremy (along with the teacher candidate) assisted with logins and reviewed procedures for those with questions and those who appeared not to be following outlined procedures or who had misconceptions about the data structure and how to work with it. As students began to use the spreadsheets he monitored their activities and occasionally took over a keyboard to correct an operation problem or fix a data formatting issue, describing what he was doing as he typed.

Certain pairs of students worked well together to solve problems. For example, one pair of boys had an issue with their graph; they had not labeled the spreadsheet data columns properly as “boys” and “girls” so the chart appeared with the meaningless labels “series 1” and “series 2” in the auto-generated chart legend. One boy noticed this and pointed out the significance of the problem to his partner, who has the computer sitting on his lap in laptop mode. After a joint discussion seeking and suggesting various possible solutions, the partner opened up the chart legend labeling box and added the correct labels to the categories.

As the double period entered its last 15 minutes Jeremy reminded the class of the documents he expected from them at the end of the period, and that they

will not be released for recess until he got their report. He mentioned several questions that students should be addressing in their reports: “What did you find that was interesting? Were things the same or different? What were they? Write three sentences.” Most students were able to finish in the allotted time although many needed the teacher’s assistance to save their files, which took up nearly all of Jeremy’s time in the last fifteen minutes of the class.

An analysis of the submitted reports revealed that the student pairs had all been successful at creating 2 by N tally sheets for recording student response by sex, had used the right procedures in summing their cells and entering that data in the spreadsheet, and had obtained interpretable graphs. Nearly all chose to use the clustered bar graph layout for their charts (with some choosing the 2D view, others the 3D); this was the most appropriate view given the data structure. All but one group properly labeled the response choices indicated by the bars and provided a properly labeled legend for the boy/girl bar pairs, but few remembered to label the count axis as “number of answers” or similar. The three summary statements provided in the reports were simple verbal reformulations of some graphed findings (e.g. “boys liked strawberry ice cream more than girls”). In contrasting the boy versus girl results no groups took into account any differences in sample size across gender; absolute counts rather than percentage of respondents were used for the analyses, which distorted the accuracy of the interpretations offered. (In fairness to the students, it should be noted that the teacher had not discussed the importance of either sampling equally for each gender or compensating for any unequal Ns by using percentages in graphing and analyses).

Bill had chosen to have his students use a different program—The Geometer’s Sketch Pad—to create floor plans for student measurement as part of a math unit he was completing on area and perimeter measurement. As he was not very knowledgeable about this program, he started the project by having Tom, the SERT teacher, lead an instructional session on tablet operation with the stylus and using the program with the stylus. Tom demonstrated tablet operations via a video projector and SmartBoard. Students then had about 90 minutes to practice using the tablets with the stylus and the Geometer program under his and Bill’s guidance. (These students had already completed instruction and exercises in calculating volume, surface area, and perimeter using formulas for various geometric shapes.)

For this project, students first created floor plans on paper for either the classroom or a room in their home. They had to measure and record room dimensions and the dimensions of major objects in the room and add these to their floor plans (which did not have to be drawn strictly to scale). These rough plans

were then to be transferred into Geometer's Sketch Pad, using the stylus rather than the keyboard to draw the lines and operate the program.

Once students had created their hand-drawn floor plan, Bill used a data projector to review how to select square graph paper as the media for drawing the plan in the software, and how to use the line draw function to lay out their blueprints. Students were then paired and told that due to a lack of a full set of tablets for the class they will have to take turns in their pairs creating their diagrams.

Even with the continual assistance of both Bill and the SERT teacher, it took over 10 minutes to get all of the tablets running the Geometer program. As students with tablets worked, many of their partners—having nothing to do—were off task, walking around and chatting.

Bill was not expecting students to enter the blueprints to scale into the program (which would allow the program to automatically calculate key dimensions once the scale ratio had been added in). When asked why, he stated that such work was more appropriate for grade seven or eight students.

Bill spent much of his time over the ensuing hour assisting students who would come to him or put their hands up with questions about operational issues, as one boy did who had difficulty in entering text into a box he had added to his diagram. Bill tried to assist these students but he did not know how to do certain operations and was often stymied; his expertise with the program was modest. For example, when a girl asked him how she can put arrowheads at the ends of the lines she is using to indicate the dimensions she is entering, he is unable to find a solution and finally suggests she enter them freehand. Tom on the other hand had more success aiding students, and came up with solutions to three difficulties that faced many of the students: how to get rid of the X and Y axes from their diagrams, how to remove the graph paper background before saving and printing their finished blueprints, and how to print their full blueprints on only one page.

Over a two hour period, neither teacher was observed helping a student with any mathematical issue such as how to calculate room perimeters or areas. Most students entered dimensions into their blueprints as instructed but about one quarter did not. Students appeared to have little difficulty using the pens to create their diagrams, but as there was no provision in the program for entering freehand labels they were forced to revert to laptop mode and use the keyboard when it came time to enter room labels and dimensions. One function students seemed to lack was easy access to a multi-step undo function when using the styli; they often had to correct lines that had “snapped” to the wrong coordinates or junctions, and difficulties in correcting errors proved frustrating to some.

Motivation and persistence amongst those working on entering their blueprints remained high throughout the double period.

As some of the students began to try to save and print their blueprints towards the end of the double period, technical difficulties all too familiar to the teachers were encountered—missing printer drivers and missing folders for saving files. Some students had to bring their tablets to Bill for help with these issues. Bill would save their files to his pen drive, and then transfer them to his own or the students' file space on the server later.

A final double period was given over to the project the next day, to allow partners who had not yet had access to the tablets to create their diagrams. The activities, work practices, and technical and operational difficulties encountered were generally the same as the previous day, but a few differences were observed. Tom wrote out on the board the procedures students needed to follow to get rid of the graphing axes in their blueprints. Bill spent more of his time helping students save their files; he was also out of the room more frequently (totaling about 30% of class time). Students who had finished their work were not assigned other work. Towards the end of the period, Bill reminded students that they had to both save their files and hand in hard copies for assessment.

The blueprints submitted by the students up to the end of this period varied considerably in quality. Some were expertly constructed with all dimensions provided and objects fully labeled; a few were replete with clearly inaccurate rhomboid shapes, lacked labels or dimensions, and had been printed with the graphing grids and axes still in view. Seven students chose to map out a room in their house; the rest constructed a floor plan of the classroom. All of the former included room and object dimensions in their plans, whereas only four of the latter did so. The plan areas and perimeters were only calculated for five home plans and two class plans. Bill indicated that he would mark their plans but that no further work would be done in class related to them.

### ***Student Perspectives on Tablet PC Use***

The students interviewed (who had all been using computers for at least the past few years, both at home and school) shared a common view on some aspects of Tablet PC use, but differed on others. Learning to use the stylus (this had been their first exposure to it) was found to be “fun” by everyone; students enjoyed any opportunities they had to “fool around” with it, exploring how it worked in applications (primarily OneNote and Geometer's Sketch Pad for Bill's class, and Journal and Smart Ideas for Jeremy's class). Some students reported uncovering some significant aspects of stylus or program functionality that had

not been demonstrated by their teacher, such as the use of the top end of the stylus to erase drawn objects or entered text, or the placing of flag markers in Journal.

Use of the stylus as an alternative to the mouse for manipulating Windows and the programs received decidedly mixed reviews. Some found it very easy to use, and a few commented that it was faster to work with than a mouse; others found that clicks on menu items etc. often did not register properly on a first attempt and had to be retried. (It should be noted that when students took a Tablet PC to work with they were never seen running the stylus alignment calibration routine, which would have customized the click-to-select process to their own use patterns and so increased its accuracy). The procedure for generating a right mouse click with the stylus was also found to be difficult to work by several students.

A few students found writing with the stylus to be uncomfortable, and preferred to enter text with the keyboard. Keyboard entry was preferred for different reasons by a few others; one student said she could type faster than she could write, and two indicated that they tended to make more errors when handwriting with the stylus, because errors were easier seen in typed text and would be corrected. Another student stated that he liked typing because it looked neater on the page. But several others thought that the stylus made text entry easier and faster because they did not have to hunt for the right keys to press.

Most students had tried to use the script to text function of the tablet, either directly in OneNote or via the operating system utility that worked with other applications. Their assessment of its efficacy differed widely; many found it didn't do a good job of "translating" their handwriting (hardly surprising given the very nonstandard nature of some students' writing at that age); others liked it, although they never wound up using it in their projects.

The students who had done the survey work in Jeremy's class were unanimous in preferring to use the Tablet PCs in tablet mode with the stylus for creating the tally sheet and collecting their data rather than doing it manually with paper or using the tablet with the keyboard. Nearly everyone thought the tally sheet easier to create with the stylus than would have been the case if they had used the keyboard, and they enjoyed the novelty of the experience. The capacity to easily customize the look of the handwritten text was seen as a positive by a few students, who liked how they could change the colour and thickness of their script.

Bill's students, who had created blueprints using Geometer's Sketch pad, were less uniformly positive about their experiences. Most did see advantages to

creating the blueprints on a computer: the end product looked much neater, with the lines appearing straight “when they were supposed to be” without having to use a ruler. One student said he found it easier than drawing with the mouse “because your hands and wrist don’t get sore”. But the majority of Bill’s students cited one or more disadvantage or problem with using the stylus to generate their diagrams, and most did not see stylus use as adding anything of value to the creation of their floor plans. Some of the limitations encountered, such as the difficulty several students reported in getting the stylus to properly select desired items when pushed down to click, were program-independent (and have been discussed above); others were a direct consequence of using the stylus with the Geometer program (it’s worth noting here that the program was not a special Tablet PC version enhanced for stylus use). In the latter category were problems encountered in getting text entered into the diagram. The program would not accept freehand script for text entry, so when it came time to enter labels and dimensions in text boxes, students were forced to revert their tablets back to laptop mode and use the keyboard. A few students remarked that they had difficulty getting the program’s “snap-to-grid” function (which they had been told to use to generate straight lines at the proper angles) working properly with the stylus, and there were several who had problems properly placing the ends of lines with the stylus. Finally, accessing the undo function with the stylus was found awkward by some, as the stylus’s eraser was not functional in the program.

There were also issues with the program itself, independent of its use with the stylus, that several students found problematic. A few students could not print their diagrams on one page, at least on the first run, and needed staff or peer assistance to make the right menu choices for this. Several others found it difficult to rid their diagrams of either the grid background and/or the X and Y graphing axes before saving and printing. And a few students had tried to use the program’s capacity to automatically calculate areas, but the program only generated the actual measurement of the targeted area in cm, not the true room area, as students had not entered any scaling factor.

Students were asked if they could think of any other school activities or projects for which they would like to use the Tablet PCs with the stylus. Several of the girls thought they could be effectively used in art class for creating digital art. The only other suggestion offered (by two students) was to use them for story writing. Several boys did indicate that would have liked more time to explore the use of the stylus with different programs and use the handwriting recognition function.

There was general agreement amongst the students that the use of computers in school made learning more enjoyable and interesting, and that it

helped them in several ways. The most commonly cited benefits related to two activities commonly pursued in their classes: conducting research for projects to find reference materials (both text and images), and different forms of writing work. Students found it much easier to locate more extensive and useful reference materials through Google searches than by using the library most of the time; they could read materials online and make notes on ideas or even copy and paste text and images into provisional documents for later paraphrasing in essays or PowerPoint presentations. One student did note that this form of research made it very easy to plagiarize materials and that this had to be guarded against. A peer remarked that plagiarizing could “work against you”: “If you are researching you’ll just copy and paste and people won’t know that you are copying and pasting, but when it comes to the test then you won’t know anything.”

Many students felt that the use of Word helped their writing by making drafts easier to edit, and they thought that the use of the spelling and grammar checkers, by allowing them to find their mistakes, improved the quality of their work to some degree.

Part of the reason interest and excitement around laptop and tablet use has been sustained in this group of students lies in the fact that their use of this technology in the classroom was only occasional, by no means an everyday occurrence. One student noted this when talking about computer use: “It makes [school] more fun because we usually don’t get it. Once in a while we get it and it would be like a treat.” While acknowledging that computer use in general made their schoolwork a little easier, they were generally dubious that it had improved their subject grades. And aside from some interest on the part of several students in exploring the stylus functions more fully, students indicated no overall preference for using the Tablet PCs in tablet rather than laptop mode, or indeed for using the tablets instead of the Dell or Apple laptops at the school.

All of the students interviewed cited difficulties encountered when using the Tablet PCs that had nothing to do with the tablets’ stylus functions, and could usually be attributed to problems with the school’s low-bandwidth slow wireless network. Students reported being regularly frustrated by a number of recurring irritants they had all experienced: the long times it took to log into the network and download software; the frequent problems locating saved files, and finding the right folders to save new files; and the occasional inability to log in, or to access printers due to missing printer drivers (a problem that could be resolved some of the time, but only by rebooting the computer). The lack of a complete class set of working Tablet PCs forced the sharing of tablets which sometimes (as with Bill’s floor plan project) left one student in the pair with nothing to do while the other worked with the tablet. Tablet maintenance was less than ideal; a few

tablets were missing keys, which make them awkward to use. Batteries in the tablets had never been replaced, and some tablets could not maintain their charge for a sufficient period; students would have to plug these machines into the wall or risk losing their work. A few students found the keyboard or screen on the tablets too small to comfortably work with. The Dell laptops at the school were thought to be better in size, speed, battery life, and state of repair, and were generally preferred for classroom use over the tablets.

### *Teacher Perspectives on Tablet PC Use*

*Teacher expertise and professional development.* During the course of the first student project observations in February, Bill had mentioned that he was not comfortable in his knowledge of Tablet PC functions and had not had specific training in them aside from a brief introduction three years ago when the tablets were first brought to the school. He had never used tablets as anything other than laptops with his students. As evidenced by the problems he encountered when trying to provide operational support to students using Smart ideas and Geometer's Sketch Pad, and his reliance on Jeremy and the SERT teacher to provide his students with operational instruction in their use, his knowledge of these programs was fairly superficial as well. In his interview he acknowledged that he relied on Jeremy and others to show him how to use programs. While he stated that the half-day tablet professional development session in March had been his most comprehensive, as he had been able to "sit and go through sort of step by step how we can use the tablet on a different level", he still did not feel comfortable enough in April to provide the instruction on stylus functionality and its use in Geometer himself, delegating that to the SERT teacher.

Jeremy on the other hand appeared not to have any problems with aiding students having technical issues in the February and April projects, but his students did not make any use of the tablet's stylus functions in the first project either. He had had the same exposure to professional development on the tablets as Bill. He saw the March inservice on tablet use as being of more limited value than had Bill, stating that "we probably could have gone into a little more detail on some more applications of the tablet functions." When asked if more pedagogical and curricular guidance for using the tablets should have been provided, though, he stated that he found the inservice sufficient as he "was the kind of person who likes just to get a taste of things and then explore them further myself."

*Usability Issues.* Both teachers highlighted the same technical and operational issues associated with the use of the Tablet PCs, and these were



identical to the ones that students had mentioned: the time wasted because of network login difficulties and the and slow application download speeds, which would preoccupy the class for 10 to 15 minutes; problems accessing student folders for loading and saving their work; and student printing problems caused by the absence of required printer drivers. Jeremy noted that:

One of the biggest frustrations that I have ...is that final question whether it's working or each kid can log in to their user ID or their account quickly and efficiently and get to the task—that would be our biggest drawback with them because we waste a considerable amount of time waiting to log in and waiting to get to what we want to do when it would be so much easier if it were just a quick one step process for it to bang and the kids are in.

Jeremy added that sometimes students would save files in the wrong places but was certain that much of the time missing folders and files were a system problem.

Bill also indicated that the burden of maintaining the tablets in a healthy and charged state was a “constant struggle”. Previous users would sometimes forget to plug in the charge cart so some tablets would be undercharged, and students would have to get cords and sit near plugs to use them. Students had discovered how to remove the keys so several keyboards had missing keys, and there never seemed to be a full class set of tablets as a few were always needing repair. Commenting on printer issues, Bill said he would sometimes have to save files to his own computer via a flash drive before he could get student work to print. A re-imaging of the tablet hard drives earlier in the year had made printing less reliable.

*Student use.* Bill thought that his students' achievement levels in both Tablet PC projects closely paralleled their typical achievement levels on other tasks:

Students that would typically do well with pen and paper are still doing equally well with tablet and stylus because they take the time and effort to do their best work all the time. So the work that you receive from them, if they were asked to do it on paper you would see that your high students give you the good quality work, you would see your lower students giving you not their best effort.

Asked to compare students' motivation and work persistence when working with the tablets both with a stylus and as a laptop, he saw both as being high but that the addition of the stylus did increase interest:

What you typically see is as soon as you give them a tablet or computer to work on they are excited to do that. I mean obviously it's a lot more fun than sitting down. So the enthusiasm level I would say normally it would be a lot higher when you are using the tablets especially in that [stylus-using] function. There are some exceptions to students that are not excited about what they are doing and they just want to do it as quickly as they possibly can and hand it in and be done with it, so I mean you are still going to get that, but I think overall they are going to be more excited to be working on the tablets.

He did notice however that when his students were creating their floor plans using the tablet stylus, a few students had commented that it would have been easier to create the lines using the drag function of the mouse as they were having some trouble getting lines to end where they wanted with the pen, and wondered why they were bothering with the pen for the task.

Jeremy had been pleased with how well his students used the styli in the creation of their tally sheets and recording respondent replies. He had been “pleasantly surprised” by how smoothly students were able to progress through the various stages of the project, from data collection to analysis, graphing, and reporting. He found their level of motivation when working with the styli high, although he did not think that unique to stylus use:

Any type of technology that we give them thus far has been very well received and the tablets were no exception, they seem to love getting new toys to play with.

Students did, he noted, demonstrate some frustration with the long delays in logging in and accessing programs, and the difficulties some had encountered with saving and printing files.

*Educational value.* Neither teacher was of the view that the use of the styli with the tablets had had any significant educational value for the students' project work. As Jeremy expressed it,

In this particular example I don't necessarily see how they've added to the educational value. I think realistically the same results could have been achieved through the old paper-and-pencil method because really it was only for the collection of the data. The advantage that I do see it from using the stylus is that it is obviously going to help us conserve paper, so rather than going through notebook after notebook after notebook this gives us the option to record the students' notes and what not and bring them up back up whenever and print them out from there. So in that sense

I can see some value to it but in the traditional sense of the actual working of the activity I think it's just as easy to do paper-and-pencil.

Bill had seen the use of the stylus with the tablet to generate floor plans as “a sort of reinforcement activity.” Asked if it had added educational value to the project, he responded:

I don't know if it's adding to the enhancement of their learning or if what they are doing by doing it a different way gives them a better understanding for it... I find it difficult to say that it enhanced the learning or if it made it any different or if it was just another way of doing it, it's a form of integrating technology into the classroom, so I have difficulty with that particular one.

Both teachers thought the tablets had had their greatest value as simply another set of laptops that they could use with their students in the same manner as other laptops at the school. They appreciated their portability which allowed them to be used easily in their homerooms rather than requiring a trip to a lab, and they saw a range of educational benefits arising from their use by students, primarily for research and writing purposes, both in terms of maintaining student motivation and accomplishing learning tasks that otherwise might be much more difficult, if not impossible. As Bill put it, “I would like to say that they are a huge benefit as a tablet but they just seem to be a huge benefit as a laptop....I think for students and using the stylus I'm still finding that they just need regular laptops at this stage as opposed to tablets.”

*Future possibilities.* Bill was not optimistic about making much use of the tablets with the stylus in the future. He noted that the floor plan project could probably have more easily and quickly been done using paper and pencil, due in large part to the overhead involved in getting everyone up and running with the tablets. He pointed out that the computer-based activities that he currently used and valued did not really benefit (as he saw it) from the use of the stylus, and cited as an example the creation of concept maps in Smart Ideas. He appreciated that his thinking about the applicability of unique tablet functionality to teaching may have been limited by his experience, and thought there could be value in more extensive professional development and support in bringing this new technology into the classroom:

We need to maybe even as teachers think of other ways, because we've been taught a certain way over the years so all of a sudden we've been given these tools and maybe with more PD or maybe with new ideas of how we can incorporate them and to see the benefits that it would be for kids—it would be wonderful, so I think if there are other benefits out

there, maybe we just need to be shown them and then we can incorporate them into the classroom as opposed to using it more as a sort of an extension of a certain activity.

Bill also thought that if school leaders placed more emphasis on exploiting tablet capacities it could encourage innovation: “Maybe if they had more concrete expectations of us to use it in that manner I think you could probably get a lot more out of it.” Jeremy foresaw continuing to use the tablets primarily as laptops. He had not closed out the possibility of using the styli for future student work if “it’s something that we are doing that would benefit from it.” But it was clear that he thought this was likely to a rare occurrence. Like Bill, he thought that teachers would have to be provided with better professional development support if the tablet’s functionalities were to be more fully applied to teaching. Asked if he found it challenging to come up with teaching scenarios in which using the styli added to the tablet’s educational value, he responded:

Yes, it’s tapping in to those creative roots and thinking “Ok how can I take this lesson and modify it to include the tablets”. It’s not so hard to modify things to include the laptops but for the tablet function there’s a little bit more creativity involved. I think it’s one of those things again where once you get rolling on it you probably will be able to come up with more uses and more reasons to use it for that function but overall unless there was some collection of lessons that could be done through I don’t think... I think we if had some kind or a bank for a database of activities that would be successful activities to use for the tablets, something that has been kind of tried and tested, I think that that would be beneficial.

## **Conclusions and Recommendations**

This evaluation focused on the use of Tablet PCs in the classrooms of the two grade six homeroom teachers at Northern Light Public School. Because these teachers were making only very occasional use of the class set of tablets, the evaluation observations were scheduled to coincide with student project work that would be making continual use of the tablets for several periods. Observations over the first of these projects found that students enjoyed working with the Tablet PCs, and generally employed them in task-appropriate and educationally sound ways as they developed concept maps using a mapping tool and then used those maps to scaffold the composition of an essay. The level of teacher-directedness across the two classes varied significantly; Bill set the categories that students were to use in their concept maps for describing animal traits and characteristics, whereas Jeremy let his students select the novel

character's traits and proofs they wished to use for their concept map and essay. Over both projects, Jeremy typically favoured a more student-centred approach in his observed teaching, but he sometimes had to abandon this when he was pressed to resolve several students' technical issues with the tablets.

In the first set of projects, neither teacher attempted to demonstrate or have students utilize any of the features or affordances unique to the Tablet PC, such as scripting with the stylus or using the stylus as an input device—in fact the tablets were not equipped with styli at the time. At the suggestion of the evaluators, a half-day professional development session on Tablet PC use in teaching was then held for these two teachers, which was intended to provide them with an operational knowledge of the tablet's unique capabilities, and to present them with project plans and ideas built around their curriculum requirements that they could implement with their students. Unfortunately the session fell far short of meeting this latter goal; it was devoted largely to instruction in the use of the stylus and its applications in OneNote, together with some discussion of employing the tablet for assessment purposes. The teachers left the session with only the vaguest of self-generated ideas about what they might do to implement stylus functionality in projects and had developed no notions of how this functionality might be leveraged in an educationally meaningful way.

A second round of projects was observed a few weeks later, projects in which students did make use of a subset of the tablets' unique capabilities, primarily by using the stylus for operating the tablet, inputting text, and creating diagrams. However with one exception (Windows Journal, used by Jeremy's students) the program versions used were not enhanced to take advantage of stylus input, which greatly reduced the utility of stylus use with the program and sometimes increased student frustrations. The Geometer's Sketch Pad, used in Bill's class, did not allow the use of the stylus to write labels or dimensions in text boxes, and its drawing interface was designed to be used with a mouse as its input device, so it did not work smoothly with the stylus for many children. Jeremy's students were easily able to create their tally sheets in Journal with the stylus, customizing their colours and line types in a way that appealed to them; but when they used Excel to create their graphs and Word to assemble and write their short reports they had to revert back to the tablets' keyboard mode, as they were not familiar enough with the script-to-text conversion utility that they might have used with these two programs.

More importantly, as the teachers acknowledged, there was very little if any substantive educational benefit to the students' use of the stylus and associated tablet-only capabilities in the projects as they were implemented, beyond a heightening of student interest and motivation. While strengthening

student motivation is certainly educationally important, much of the observed benefit in that regard would likely wane once the novelty of using the stylus wore off. Both teachers noted that central parts of their respective assigned tasks might have been more efficiently done by using the tablet as a regular notebook computer (for creating the floor plans) or by using a traditional paper and pencil approach (for drawing up a tally sheet and collecting survey data). For both projects the use of tablet features had a “tacked on” quality; it seemed evident that little or no thought had been expended on developing a pedagogical rationale for their employment, or shaping the project activities so that tablet use added significantly to their educational outcomes.

There was a more general problem with the use of the Tablet PCs that had negative pedagogical consequences. In all the classes observed in which students were using the tablets, a very substantial amount of teacher time (typically over 50%) was absorbed in dealing with the various technical limitations and problems students encountered logging in, finding and saving files, and printing. This was true even though a second teacher (the SERT or a teacher candidate) was also in the room for most of the observed tablet sessions, assisting students in the same manner. These difficulties arose largely due to the very slow and error-prone wireless network architecture used at the school, and the fact that most applications did not reside on the tablet hard drives but had to be downloaded over the network. These drawbacks had a very high opportunity cost for the teachers, greatly reducing the time they had to spend functioning as “real” teachers focusing on substantive educational goals, guiding students individually and in small groups. In a number of observed instances, teachers did not address a substantive curricular or pedagogical issue for ten minutes or longer due to the press of dealing with students’ technical or operational issues with the tablets.

While the outcomes of these teacher projects with respect to tablet use were hardly encouraging, we do not feel that the educational potential of Tablet PCs has been adequately tested in this trial as a number of changes could be made in both the preparation for and implementation of Tablet PCs in the classroom that would very substantially improve the likelihood of attaining much more successful outcomes. If a serious and meaningful exploration of the Tablet PC’s educational potential is to be undertaken at some future point at Northern Lights Public School, it will need to be preceded by much more extensive capacity building at both the technical and teacher levels. Only if the recommendations provided below are implemented will it be possible for the school and board administrators to assess the true potential Tablet PCs have to enrich students’ education.

***Recommendation 1. Implement improvements in network architectures that allow rapid and reliable access to programs, files, and folders, even under heavy load conditions.*** Teachers cannot afford to lose 30-50% of their teaching time whenever they choose to use tablets with their students. The technical burdens imposed by the present system (which have not significantly improved since they were highlighted in the first evaluation report two years ago) limit teachers' willingness to use technology in the classroom and seriously degrade the quantity and quality of their teaching when they do so.

***Recommendation 2. Provide teachers with meaningful opportunities for professional development related to tablet use.*** Release time should not be solely devoted to offering workshops on the technical and operational aspects of Tablet and program use, although these are needed (as evidenced by Bill's difficulties in working with certain programs). Of equal importance are opportunities for teachers to be exposed to a range of carefully prepared, curriculum-relevant tablet-based activities that make use of the tablet's unique capabilities in educationally powerful ways.

***Recommendation 3. Provide teachers with ongoing support for integrating Tablet PCs into their curricula.*** This support needs to go beyond the occasional workshop. Current research on teacher professional development suggests that for it to be effective, professional development must be long-term, school-based, collaborative, focused on students' learning, and linked to curricula. This implies that teachers need opportunities and release time to experiment with the tablets, assess student outcomes, reflect on their experiences, and share them with colleagues and professional development facilitators on a regular schedule throughout the school year.

***Recommendation 4. Provide teachers with resources to assist them in integrating Tablet PCs into their teaching.*** At present virtually no Tablet PC-specific curricular resources exist. Microsoft and/or the York Region District Board of Education need to dedicate personnel to the development of tablet-enriched pedagogical activities for different strands and units in the curriculum, as teachers do not have the experience, time, or training needed to successfully undertake this on their own time. The Tablet PC lesson plans and teaching ideas developed need to be shared through a common portal that provides for reflective and mentored practitioner discussion around the plans and implementation experiences.

***Recommendation 5. Improve the quality and timeliness of technical support for Tablet PCs.*** As it stands teachers do not have access to a full class set of tablets, so some students get paired during activities that are really meant to be

individually pursued, with the consequence that many students get off-task. Old tablet batteries need to be replaced to minimize the disruptions caused by the need to plug in the units, and any missing keys or styli restored to the units.

***Recommendation 6. Assign the tablet set to one (or at most two) classes for a full year.*** The very occasional schedule of tablet use observed this year did not allow students sufficient time to become proficient in the operation of the stylus as an input device, or to become knowledgeable about or able to utilize the capabilities of tablet-enhanced programs such as OneNote. These skills are prerequisites for fully exploiting the tablet's educational potentials. Intensive and extended use over the year, if properly guided by a knowledgeable teacher, would greatly enhance the likelihood of tablet use contributing significantly and in unique ways to students' educational experience.