NOTE TO USERS

The Challenges and Benefits to Teachers' Practices in Constructivist Learning Environments Supported by Technology

Carmen Sicilia

Department of Educational Counselling Psychology

McGill University, Montreal

Montreal, Canada

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Abstract

This research is intended for educational policy makers. This is an exploratory study that investigates Quebec's classrooms as a new educational reform is implemented. There are two relevant pieces of legislation in the reform that elicited this study. First, teachers are required to adopt constructivist teaching practices; second, teachers must use ICT in classrooms. The questions being addressed are: 1) What are the current challenges and benefits impacting teachers with the integration of computers in the classroom environment? 2) What do classroom practices look like given a) in the context of Quebec's constructivist-learning environment and b) the possibility of ICT support. Case studies with teachers from elementary and high schools show changes in teacher and student role; however, lack of guidelines hinder constructivist teaching practices. Five predominant challenges were identified: lack of personal development, lack of time, technical support, accessibility, and classroom management. The study also identifies five elements as benefits: sharing of information; communication; editing; monitoring; web access.

Résumé

Cette recherche s'adresse aux concepteurs de politiques. C'est une étude exploratoire portant sur les salles de classes québécoises au moment de l'implantation de la nouvelle réforme de l'éducation. Deux lois de la réforme sont à l'origine de ce projet de recherche : d'abord, les enseignants doivent favoriser l'approche par compétences; ensuite, les enseignants sont tenus d'intégrer les TIC dans leurs classes. Voici les questions soulevées : 1) Quels sont, pour les enseignants, les défis et avantages actuels de l'intégration des ordinateurs dans leurs classes? 2) À quoi ressemble l'enseignement dans un environnement où l'on favorise l'approche par compétences et l'intégration de la technologie? 3) Les enseignants parviennent-ils à adopter ces méthodes? Les études de cas menées auprès d'enseignants d'écoles primaires et secondaires révèlent des changements au niveau des rôles d'enseignant et d'élève; par contre, le manque de directives générales entrave la mise en pratique de l'approche par compétences. Nous avons identifié cinq défis majeurs : manque de développement personnel, manque de temps, assistance technique, accessibilité et gestion de classe. L'étude identifie également cinq avantages : partage d'informations, communication, révision, encadrement et accès à l'Internet.

Chapter I

INTRODUCTION

In response to important changes that have occurred in modern society over the past few decades, many governments have undertaken major reforms of their education system. The Quebec Government is no exception. In September, 2000, the Ministère de l'Éducation du Québec (MEQ) outlined a new education reform (Ministère de l'Éducation, 2000). This reform was based on world wide research on education, which suggested that a comprehensive and diversified curriculum can best prepare the students as future citizens who can meet the challenges of a pluralistic society and a job market that is constantly evolving and changing (Bruleux, Laferriere and Lamon, 2002; Duszara, personal communication, May 4, 2005). In essence, the purpose of the reform was to build a community of lifelong learners by bridging the classroom learning with real world experiences.

As lifelong learners, students are given the opportunity to reflect on their experiences, helping them to construct their own understanding of the world they live in (Brown, Ellery & Campione, in press). This new approach to education sees learning as a process, the student as the principal agent in that process, and, situations that are seen as most conducive to learning are those that present a real challenge to students by obliging them to reexamine what they already have learned.

The pedagogical perspective influencing the thinking behind the current Quebec reform is constructivism. Drawn from socio-cultural perspective,

constructivist theory is the most important theory that is changing how classrooms look today. Constructivism is a collection of theories of knowledge of learning including, situated learning (Brown, Collins and Duguid, 1989), communities of practice (Wenger, 1998) and cognitive apprenticeship (Collins, Brown and Newman, 1989).

Constructivism is the belief that teachers need to do more than simply deliver information to students: they need to design activities which facilitate students' engaging with and making sense of the content. Learners must be given the opportunity to build on prior knowledge, beliefs and experiences and encouraged to be autonomous and take initiative. Taken from this theory is the perspective that a constructivist classroom tends to focus on learning in context and collaboration. Students are asked to solve realistic and meaningful problems that demonstrate real-life situation by relating the concepts being taught with a real-life activity or event and by processing and analyzing information.

The education reform program is designed to help each child establish links between classroom learning and everyday life. Through individual or group activities or projects under the supervision of their teacher, the student will have the opportunity to become familiar with ideas and practices that are related to today's world. Specifically, the education program features eight areas of lifelong learning, in which a child will learn to:

- develop a world-view that will give more meaning to his or her life
- live harmoniously in society
- develop his or her critical judgment

- cultivate a healthy lifestyle
- establish good relations with others
- develop a sense of responsibility for the environment
- recognize the importance of being an informed consumer
- understand himself or herself, take part in society and make appropriate choices for the future.

To develop lifelong learners, there are two elements to this reform: first, it is a competency-based approach, second, it focuses on the learning process. A competency is defined as a set of behaviours based on the effective mobilization and use of a range of resources (Ministère de l'Éducation, 2002). The set of behaviours refers to the capacity to use appropriately a variety of resources, both internal and external, and in particular, learnings acquired in school or in everyday life. One aim of a competency-based program is to ensure that students' learnings serve as tools for both action and thought, which is a form of action. The resources used by the student are referred to as prior knowledge, both what they have learned at school, and their experiences, skills, interests, etc. In addition to these internal or personal resources, students may also rely on external resources, such as their classmates, their teacher, culture, technology etc. Thus, a child's learning focuses not only on *what* is learned but also on *how* knowledge is acquired. (Anderson, Greeno, Reder, & Simon, 2000).

The conceptual learning process is a critical element to the changes imposed by the reform as it defines learning as an active, ongoing process of construction of knowledge. The way the students are taught to acquire, develop, and master the

competencies require school educators and teachers to make changes to their instructional approaches. Teaching becomes more student-centered and therefore, the approach of curriculum delivery is designed through active learning process. Student-centered versus teacher–centered refers to the learning paradigm as an active engagement with knowledge, rather than a passive one, the focus is on activities that require students to find solutions to problems. Since there are more activities, less knowledge is based on rote memorization (Brown & Campione, 1994). A student-centered classroom tends to focus on learning in context and collaboration. For example, in addition to drawing 'b' or 't' in an exercise book or counting imaginary balls and tops, a young child may learn to read or add by participating in a group project.

In order to support the active learning process, the reform mandates the adoption of Information Communication Technology (ICT) for supporting teaching and learning. ICT refers to exciting and creative ways to provide lifelong learners with global access to information (RECIT, 2005). An example would be the use of the World Wide Web as a resource.

In June 1996, the MEQ initiated a technology integration plan in order to facilitate teacher learning of technology. Out of the report, RECIT was born (the Réseau pour le Dévelopment des Compétences par l'Intégration des Technologies). These resource people were and are still today appointed by each school board, and their primary purpose is to train and provide ICT to support teachers. Teachers who want to use the resources of Internet as part of their teaching strategies can access the RECIT website which offers ready-made projects and activities which

they can either join or use in their own classroom setting, as well as, retrieve feedbacks and tips on how to explore and use new technology media. According to RECIT, the main focus today is the same as when they began, to link the use of technology and the curriculum in the spirit of the current educational reform (W. Duszara, personal communication, May 4, 2005).

In the following section a brief background will be introduced on studies on the challenges and benefits in adopting ICT in classrooms, and studies that focused on constructivist teaching practices supported by ICT. The subsequent sections will focus on this study's problem statement, theoretical perspective, research methods, results, discussion and the conclusion.

Chapter II

LITERATURE REVIEW

Overview

There is no shortage of research on the relationship between computers in classrooms and education. This research can be found in psychology, education, anthropology, sociology and technology journals. A considerable number of studies addressed the issue of teaching practices (Cuban, 2001; Bracewell, Le Maistre, Lajoie, & Breuleux, in press; Windschitl & Kurt, 2002) and many more related to the struggles and problems which impeded the integration of technology in the education system (Fishman & Krajcik, 2003; Sandholtz, 200; Thammavong, 2004). A background on studies that look at the challenges and benefits of constructivist teaching practices supported by ICT is presented in the first part of the literature review. This is followed in the second part by teaching practices in a constructivist-learning environment supported by technology

Challenges hindering teaching with adoption of ICT in constructivist teaching environment

Recent literature on ICT in classrooms has pointed to four major challenges: teachers' beliefs, professional development, classroom management and the lack of time. Each of these challenges will be presented in this section, followed by the benefits of ICT in a constructivist-teaching environment.

Teachers' Belief

Computers serve many purposes in schools: Make schools more efficient and productive than they currently are, transform teaching and learning into an engaging and active process connected to real life, and prepare the current generation of young people for the future workplace (Cuban, 2001). It is for these reasons technology is being introduced in classrooms at an accelerated pace. However, before any commitment is made to integrate technology in the school, school administrators need to have conversations with teachers to reveal teachers beliefs about learners and learning and how technology facilitates the progress of classroom goals (Barnett, 2003; Windschitl & Kurt, 2002).

The introduction of technology has created not only changes with the dynamics of the classroom but also a breakout of tremendous ranges in teaching practices because of the different philosophies and beliefs about the use of information technologies by teachers (Becker & Riel, 2000).

Windschitl and Sahl (2002) conducted a two-year study on the use of laptop computers in a middle school and the teachers' beliefs of the students in their particular school, what constituted "good teaching" in the context of the institutional culture, and the role of technology itself in the lives of students. Findings showed that the influence of technology on instructional decisions was mediated by the teachers interrelated beliefs systems. Teachers exposed to the same conditions of infrastructure, administrative support, and exposures to models of pedagogy had different outcomes with the use of technology. One reason was that the teachers' decisions to use technology in their classrooms were congruent with

their beliefs about learners and their needs, and consistent with images of what counted as learning activities in specific subject matter areas (Windschitl & Kurt, 2002).

Therefore, prior to introducing any ICT program in a curriculum Harvey (2003) recommended to provide training to teachers in order to help them develop a belief about the relationship between technology and curriculum, specifically, that technology does not drive the curriculum but rather the curriculum that drives the use of technology. According to Harvey (2003), doing so would empower teachers to find appropriate ways of integrating the technology with their ongoing instruction rather than viewing ICT as an activity disconnected to the curriculum content, standards, and requirements.

Professional Development

Other research dealt with the obvious need for teacher training on technology to accompany implementation of new technologies in schools (Fishman & Krajcik, 2003). Before teachers can regularly create technology-enhanced instructional units and be innovative to take full advantage of technology enhanced curriculum and learning activities, teachers need to master hardware and software (Mandinach & Cline, 1992).

Many teachers may feel unprepared to use technology because they lack troubleshooting skills, and have limited access to manuals that might enable them to solve their own problems (Sandholtz, 2001). Hence, providing teachers with more technical training would serve several purposes: increase their comfort level

to fix the problems when they occur, learn more about new technology skills, and hence increase their ability to change their teaching practices (Barnett, 2003).

Thus, to empower teachers and students to learn with computers, administrators and policymakers must plan for ongoing staff development that takes place in large groups, one-on-one, or online (Fishman & Krajcik, 2003). This is not a one-time deal. It is not a matter of buying the computers installing them and sitting back to enjoy the difference they make. Therefore, ICT in education was researched as being most likely to have a positive impact on learning when accepted as a long-term commitment.

Classroom Management

The introduction of computers to a classroom creates complex issues for classroom management. It is not a question of using computers from time to time, since computers are making their way in many of the classrooms, but accepting them as part of a teacher's everyday working environment. The challenge is that technologies often call for changes in classroom structure such as collaborative group work or project based learning, which involves new approaches to classroom management and organization of knowledge and assessment (Fishman & Krajcik, 2003). Adopting information technology in the classroom is, in many ways, no different from adopting other pedagogies, but teachers see this integration as something that they have to control through their experience and knowledge, and as a way to steer the change in a direction that they have to understand and which they feel will be beneficial to their students (Sasseville, 2004).

Incorporating the use of computers in the curriculum can be challenging and daunting for a teacher, particularly a novice teacher. Based on several years in the field observing and speaking to educators in Quebec, and looking at their changes and practices, Bracewell et al. (2003) found that when teachers were initially introduced to computers in the classroom, the teachers were concerned with discipline, with resource management, and with direct control of students' computer activities.

Brophy (1998) found that teachers' concern with control was often due to their lack of skills on how to facilitate students' activities, similar to a business manager facilitating employees' activities. The key to successfully managing a classroom was determined as having the teacher maximize the time that students spent actively engaged in academic activities, while minimizing the time that they spend waiting for activities to get started. In other words, having students sit with nothing to do increased the possibility of student misconduct (Brophy, 1998)

Lack of Time

A teacher's work schedule involves teaching, grading, designing curriculum, meeting with students, administration, parents, and for many, supervising after school activities. For these reasons teachers may experience the frustration of not having enough time to learn the new technology (Aaron, Dicks, Ives, & Montgomery, 2004; Fishman, et al., 2001; Thammavong, 2004). Leclerc (2003) provided an interim report which described the changes experienced by teachers after they participated for three months in a project to integrate information

and communications technologies (ICT) into an Ontario secondary school. The goal was to determine what changes occurred and what factors either fostered or impeded them. The participating teachers perceived active leadership in the school and social pressure to be the emergent positive change factors, but they viewed a lack of available time as a main constraint.

The barrier with time was considered as not only interfering with the teacher's ability to experiment with technology but also the opportunities to talk with other teachers about what they were doing with the technology (Sandholtz, 2001). When this issue was dealt with or minimized, teachers were able to make changes in their instructional practices and level of technology use, and reported having greater levels of comfort with the use of the equipment (Sandholtz, 2001).

Benefits with adoption of ICT in constructivist teaching environment

A number of researchers have identified the benefits of integrating ICT in classrooms (Altalib, 2002; Bracewell et al., in press; Cuban, 2001; Jonassen, 2002; Plomp et al., 1996). Cuban (2001) claimed that there are three ways that information technology can be beneficial to the students: first, it grants them direct access to facts, ideas and primary resources. Second, it links images and concepts to sound and film, which allows students to produce creative and professional presentations rather than collages or poster board. And third, it motivates students, especially those who would not otherwise be engaged.

As wireless computers are rapidly beginning to make their way into classrooms, numerous advantages have been found, such as: Teachers and educators become less tied to the time consuming task of mainly delivering lecture-based instruction (Altalib, 2002), educators have time to focus more closely on the learners' needs (Altalib, 2002; Bracewell et al., in press), students can take greater responsibility for their own learning (Altalib, 2002; Bracewell et al., in press; Windschitl, 1998), and lastly , learners are able to access information from many more resources than just one teacher or textbook (Altalib, 2002; Breuleux, 2001; Windschitl, 1998; Cuban 2001).

The integration of ICT in curriculum provided students with representational tool, which allowed them to create explicit and public works that could be accessed by teachers. (Bracewell et al., in press; Plomp et al., 1996). It also provided teachers with more time to engage in individualized instruction for both single students and groups (Bracewell et al., in press). Both teachers and students could assess the performance which make the evaluation process a total interactive, interpersonal human process (Plomp et al., 1996).

ICT can be beneficial in the evaluation process by providing the ability to institute ongoing support for the students' progress. Access to website usage have shown beneficial factors both for teachers and students. Teachers and students are not only using the web to search for information (Bracewell et al., in press; Plomp et al., 1996), but to change the way communication and learning occurs in education (Bracewell et al., in press; Plomp et al., 1996). The web brings in more

people, different perspectives, different voices in the classroom. It opens the door not only for the voices inside the class to be heard outside, but also, reciprocally, for minds outside to be present within the class (Breuleux, 2001; Windschitl, 1998). In such situations, the student can be an active participant in the actual community of practice.

Other benefits of on-line access that support learning identified by Windschitl (1998) were: provided a wealth of primary sources with exhaustive information and links to other pertinent sites, prompted student-generated questions, provided multiple perspectives for all disciplines, information on current events, provided information in the form of imagery adding richness, and readily available data sets from government agencies and other institutions for inspection or downloading. "This ability to move, via link, through virtual space is an intellectual lever for learners who can use this flexibility to construct their own understanding of a body of information" (Windschitl,1998, p. 1).

ICT in Constructivist Teaching Practices

Technology is being used to support teachers to deliver the curriculum to be practised in a new learning environment for students. However, technology, will only lead to changes in teaching practices depending on how it is designed, and for what purpose (Means & Olson, 1997). A learning environment based on ICT should not look or feel like a traditional classroom (Kruger, 2000), nor occur in

traditional educational institutions because the most productive and meaningful uses of technology engage learners in: knowledge construction, not reproduction, conversation not reception, articulation, not repetition, articulation, not repetition, collaboration not competition, and reflection and prescription (Jonassen, 2002). The challenge for teachers, administrators and policymakers, then would be how to combine what we know about creating lifelong learners with the possibilities that are presented through the use of technology.

Quebec researchers (Bracewell, et al., in press; Leclerc, 2003) and American researchers (Plomp, Ten, and Rapmund, 1996) have found that new teaching practices in a constructivist environment alter both the role of the teacher and student that are reflective of the presence of technology in the wake of a new reform. Bracewell et al., (in press) conducted a study with grades 5, 6, and 7 in Montreal and Kahnawake (aboriginal community) classrooms. Both teachers and students, with only three months of experience with technology in the classroom, showed a major shift in roles and responsibilities. For example, a problem found by the researchers with technology in the classrooms, was that the curriculum content was contained in the textbooks and worksheets, and not on the computer. To deal with this problem, the teachers began capitalizing on the students' expertise and sense of ownership, setting up activities using data software to input content to the computers. The distribution of the responsibility across the classroom gave the students a sense of ownership. The authors labelled this phenomena "release of agency." In other words, the teachers had to accept that the new technologies allow for greater sharing of learning, not only between teachers and students but among

students, and that they allow students to direct a good deal of their own learning. It was the decision that accompanied a teacher to make well-documented change in roles from a didactic instructor to a coach which facilitated student academic inquiry. "An important consequence of this decision is that the teacher relinquishes the role of sole expert in all matters in the classroom" (Bracewell et al., in press, p.11). In some schools, having computers in classrooms did not necessarily initiate teachers' movements towards a pedagogy or role change (Cuban, 2001; Plomp et al., 1996; Windschitl & Kurt, 2002). Many teachers were still more likely to engage their students in traditional (non-technology based) activities than in technology-based activities (Abate & Bagaka, 2002). The technologies that were more likely to be engaged by teachers were word processing, internet, and email, rather than in productivity tools (Abate & Bagaka, 2002).

A constructivist teaching strategy consists of five basic elements: activating a student's prior knowledge, acquiring knowledge, understanding knowledge, using knowledge, and reflecting on knowledge (Tolman & Hardy, 1995). Activating prior knowledge is very important since what is learned is always learned in relation to what one already knows. When teachers were familiar with a students' prior knowledge they were able to provide learning experiences to build on the existing understandings (Steffe & D'Ambrosio, 1995).

Constructivist teaching practices supported by technology encouraged students to be actively involved in the process of gathering, organizing, analyzing information, and using information to make informed decisions that relate to life (Plomp et. al., 1996). Students focused on activities that required them to find

solutions to problems and to reflect on the process of learning and the product of that process (Brown & Campione, 1994). "The classroom environment thus becomes a much more heterogeneous one with respect to students activities than that the traditional classroom, one which offers the opportunity for a greater variety in instructional techniques" (Bracewell et. al., in press, p.13). Laferrière, Bracewell, Breuleux (2001) referred to this education paradigm change as "reconfiguration of time and place for learning, but most importantly new ways for learners, including the teacher as learner, to collaborate and establish relationships with other individuals and knowledge objects" (p. 6).

Adopting ICT in any constructivist-learning environment can be a challenge and barrier for any educational leader when there is a history of limited ways of using it (Fishman et. al., 2001). Although many curriculum reforms have included the use of technologies, new teaching practices cannot emerge over night. Constructivist-learning environment takes planning and the input of many others besides the teacher. As many researchers have claimed, for education reform to occur, planning needs to occur within the context of the entire school or government strategic planning process (Aaron, et. al. 2004; Barnett, 2003, Fishman, Soloway, Krajcik, Marx, & Blumfeld, 2001).

In the next section, the problem of the study will be introduced, followed by the theoretical perspective taken to conduct the research, and research questions.

Chapter III

PROBLEM STATEMENT

A great deal of research has addressed the issue of teaching practices, challenges and benefits of ICT in classroom. The problem addressed in this study focused on the newly adopted education reform in Quebec which requires the teachers to adopt the constructivist teaching practices and the usage of ICT in their classrooms. Although the questions of constructivist teaching practices and ICT challenges and benefits in classrooms are not new, it is important to re-examine because the Quebec education reform is in its third year of implementation and it is important to investigate how teachers are adopting the changes imposed on them.

Theoretical Approaches to the Study of Teaching Practices

This research was driven by two theoretical perspective: Grounded theory and socio-cultural theory. The two approaches provided the foundation to research the questions.

Grounded Theory

The phrase "grounded theory" refers to a theory that is developed inductively from a corpus of data. What differentiates grounded theory from many other qualitative studies is that it is explicitly emergent. Grounded theory does not test a hypothesis, but rather, sets out to find what theory accounts for the empirical

situation as it is. In this respect, it is like action research because its aim is to describe the situation that is being studied (Strauss and Corbin, 1990).

Grounded theory takes an empirical case rather than controlled variable perspective. This means that the researcher focuses on the subjects and the experiences of these subjects, "without pigeonholing or delimiting what those experiences will be in advance of fieldwork" (Patton, 1990). Grounded theory relies on methods that take the researcher into and close to the situation so that the results and findings are "grounded" in the empirical world (Patton, 1990). There are three reasons why this methodological approach is appropriate for this type of study. First, through the interviews which were the basis of the grounded theory, captured each teachers' unique experiences as they told their stories, Second, the stories were used to identify patterns across the subjects. And third, these patterns made up the characteristics which provided a glimpse of what the classroom world looks like.

Sociocultural theory

Sociocultural theory, which focuses on communities in which individuals participate, has had a profound implication for teaching and education (Lave & Wenger, 1991). Its foundation is heavily drawn on the work of Vygotsky (1986). A key feature of this emergent view of human development is that higher order functions do not occur in a vacuum but are developed out of social interaction. Vygotsky (1986) argued that a child's development can not be understood by a study of the individual. Researchers must also examine the external social world in

which that individual life has developed. Through participation in activities that require cognitive and communicative functions, children are drawn into the use of these functions in ways that nurture. The benefit of using sociocultural theory in this study was to move away from the cognitive attributes and towards the collaborative interaction that occurs as teachers attempt to develop different teaching practices.

Research Questions

The following research questions were developed for investigation:

- What are the current challenges and benefits impacting teachers with the integration of ICT in the classroom environment?
- What do teachers' practices look like a) in the context of Quebec's constructivist learning environment and b) when supported by technology?

This research has two main purposes: first, to examine the present critical issues and problems faced by teachers when computers are integrated in a constructivist classroom setting, second, to investigate classroom practices when technology is available. For the purpose of this study, classroom practices refers to the artifacts, behaviours, activities, things teachers employ in as part of their teaching function and classroom structure that help students acquire knowledge.

Chapter IV

METHODS

Overview

This is a case study focusing on teachers' practices in an English private and a public elementary school in Quebec. This study follows the guidelines set out in the Statement of Ethics for Human Participants that is required by the McGill University, Faculty of Education and in accordance with the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (1998) (see Appendix A1). All participants, teachers, students, administration and parents of students interviewed, observed or videotaped provided formal written consent (see Appendix A2 and A3). For the purpose of this paper the names of both schools, school boards, and teachers have been changed to preserve anonymity.

School Sites

Two schools were selected for this study. Montebello School is an all-boys private elementary and high school located in the Montreal West End, with a population of 570 students. The school is not affiliated with any public school board but is partnered with seven other English private schools in the city of Montreal under the organization name, Quebec Association of Independent Schools (QAIS). Montebello School is also a member of The Canadian Educational Standards Institute (CESI), an organization with a mission to promote educational

excellence through a rigorous school accreditation process. There are seventy-eight teachers in the school, two full time and one part-time computer technicians and a full-time educational pedagogical administrator.

The students are mostly from upper social economic status, are highly motivated and have average to above average educational abilities. The school was selected because last year it moved from cart computers to a laptop program with all their 7th through 10th graders (11th graders are not on the laptop program) and the school has been actively participating in promoting technology in their curriculum in all subjects. Cart computers are computers that are placed on a cart and rolled into a classroom when needed by the teacher. Presently, there are close to four hundred and fifty laptops in the school. In the last three years, the teachers at Montebello have attended several outside professional development workshops and in-house training in learning what constructivist classroom looks like and how to incorporate ICT in the classroom.

The second school, Mont Laurier, is a public elementary school located in the North End district of Montreal. This school is part of the Wilfrid Laurier School Board and it represents Montreal's multicultural population. It serves students that are from different ethnic groups, and religious groups, and is multilingual. For more than half of the students in the class, English is not their mother tongue. The school has 15 classrooms with a teaching staff of 15 teachers. The average class size is between 25 and 27. The school also has mixed inclusion program, that is, students who require special needs education are in the same classes as main stream

students. The school had no on-site pedagogical consultant and no on-site technical staff.

A reason these two specific schools have been selected for this study is that the teachers are completely immersed in the constructivist classroom supported by ICT. Furthermore, Mont Laurier teachers have been participating in pilot studies with McGill University on the integration of ICT in education for the last five years.

Participants

A total of six teachers were interviewed twice for this study to investigate the first question, "What are the current challenges and benefits impacting teachers with the integration of ICT in the classroom environment?" Four of the teachers were from a private middle school and two from a public elementary school. Only one out of the six was selected to look at the second question, " What do teachers' practices look like given a) in the context of Quebec's constructivist learning environment and b) supported by technology?" The reason only one teacher was observed is because the principle aspect of this study required the teachers to incorporate the web or any other software or hardware in the curriculum, particular through interactive activities. After reviewing the interviews three teachers met that criteria but only one was integrating any activities with the support of ICT at the time of our study.

Brief characteristics of the six teachers selected for the analysis to explore the research questions are described below. The first four teachers, Jorge, Mike, Kate, and Mary, are from Montebello School, the private school, and the other two teachers, Francine and Dan, are from Mont Laurier School, the public school.

Jorge

Jorge, has been teaching for over 20 years. He had a dual role in the school as a fulltime 7th grade science teacher and ICT pedagogical trainer for teachers. His peers have classified him as an effective teacher. He was the first in the school to have a wireless classroom. Jorge was a keen user of technology and a teacher who played an important role in integrating the vision of ICT at Montebello. His science class was also selected to observe and videotape. There were 20 students in his class.

Mike

Mike has been teaching for 10 years and he was teaching math to 10th grade boys. He too, like Jorge, had been described by other teachers as a solid resourceful person to seek out when in doubt about technology. He not only possessed a teaching educational background but a degree in programming. He was attending some formal training on how to adopt constructivist practices in the classroom. There were 20 students in his class.

Kate

Kate has been teaching for 7 years, and she too was teaching math to 10th grade boys. Unlike Jorge and Mike, Kate was less comfortable with technology and was selective in how she applied it in her classroom. Kate had recently returned in the fall from maternity leave and had been away for the entire year during the school's integration of the laptops. Prior to leaving for maternity she was using the cart computers and participated in several professional training programs on software applications. There were 20 students in her class.

Mary

Mary is a novice teacher with only 2 years of experience. She was teaching math and biology to 10th grade boys. She had only been at Montebello for one year and had been working on her own in learning about how to use ICT in classroom. Mary was not comfortable with using ICT in all subject matter. She was selective how and when she would use technology. She had not attended any formal training, only one informal information session during a teacher pedagogical day. There were 20 students in her class.

Francine

Francine, a teacher with 35 years of seniority was teaching the 1st and 2nd graders. Francine had received a lot of technical and pedagogical support from two research assistants from McGill University and made good use of the ICT support

provided by them. She used extensive videotaping and iMovie software to create portfolios on each students. There were 27 students in her class.

Dan

Dan also a teacher with over 30 years of experience had been adopting constructivist classroom practices for over five years, but using computers with his students for the last 10 years. He was considered to be the teacher with the greatest ICT ability at Mont Laurier. He used digital cameras, videotaping, emailing tools with his pupils, and used portfolios to conduct student evaluations. There are eight desktop computers in his classroom which teams of students share.

Data collection

One way to understand what impact computers have in education is to provide a rich description that reveals teachers' insights and experiences which, in turn, can be used to understand the instructional practices of their classrooms. Therefore, qualitative methodology is an appropriate data gathering method. Through the grounded analysis made from observations, interviews, and videotapes, this approach provides a rich description of the problems confronting teachers having to integrate ICT in a constructivist classroom.

Since a qualitative approach was utilized, the validity of the research relied on data from multiple sources:

- Interviews were the main source of data collection. Regular formal and informal semi-structured interviews with teachers and school administrators, pedagogical consultants and MEQ representatives were conducted.
- Classes were observed, videotaped, audio-recorded during all whole-class time. In addition, field notes were taken by the researcher, before, during and after observations.
- Documentation used by teachers was collected.
- Documentation on the MEQ policy and recommended instructional practices, and technological implications were used.

The six teachers were interviewed once at the beginning of the school year, and a second time in the winter, half way in the school academic year, and one of the six teachers was observed near the end of the school year. The first set of interviews focused on drawing out teacher's challenges and benefits about ICT (see Appendix B1). The second set of interviews was designed to become familiar with the school's structure and teachers' classroom practices on specific classroom activities carried out (See Appendix B2).

Data analysis

Careful attention was given to the process of data analysis to ensure the validity in the interpretation. The data from different sources were used for analysis, and during the data collection regular meetings and discussion between

researchers became crucial in identifying emerging issues and topics. Case-analysis and video-analysis and were the principle methods used to analyze the data. A description is presented in the next section.

Coding Analysis

To explore the first question, inductive analysis was done on the transcripts taken from the six teachers' interviews. The question was: What are the current challenges and benefits impacting teachers with the integration of ICT in the classroom environment?

The process taken was the following: After each interview and field notes were collected, key themes were identified and noted down, the data from the six interviews were then each coded and emerging themes, links and relationships were noted and identified. The procedure used for coding was established by Bracewell, Breuleux & LeMaistre (1997). A complete model is shown in Appendix C1.

Through the use of the model the teachers' positive and negative evaluations of ICT in constructivist classroom were identified. Characteristic of an evaluation is an attributed or truth value relation associated with ICT. Table 1.0 shows what an evaluation is along with an example. An example of a negative evaluation indicating a challenge from a teacher was:

> "That's something I really—that's my biggest problem with it [classroom management]. It's just that management of who's really paying attention".

The phrase *biggest problem* was then coded as a negative attribute evaluation for classroom management.

An example of a positive evaluation indicating benefit was:

> "... one thing I'm really using a lot is communicating with them via their computers. I just find it—it's really easy to give reminders, it's easy to distribute homework, it's easy to get in touch with individual students about particular problems."

The word expressing the evaluation *easy,* would then be coded as a positive evaluation for email communication.

The strength in using this framework was that it clearly guided us in identifying how teachers evaluated and assessed the integration of ICT in their classrooms. And the analysis of the coding of transcripts using this model clearly identified patterns of challenges and benefits in which computers are introduced and how classroom practices were affected by the implementation of technology in curriculum.

To assess the degree of coding reliability, a test was conducted between two independent researchers. Independently, the two researchers coded the same transcript and then reviewed the coding of the two transcripts. A result of 84% reliability was obtained, which can be seen in Table 2.0. This was an acceptable level of coding because of the high redundancy of evaluations in the protocols. It is likely that the missed coding had minimal threat to the validity issue of the coding of the themes which the teachers referred to as a challenge or benefit.

Video-analysis

To explore the second questions, video observations of Jorge's classroom were conducted. The questions again were: What do teachers' practices look like

a) in the context of Quebec's constructivist learning environment and b) supported by technology?

The video analysis provided a comprehensive and richer description showing the extent to which teachers are changing their traditional teaching practises and fostering the new practices. In order to analyze the video-recorded observations, two observational forms were developed by the researcher. Both these models were used as "sensitizing" constructs (Glaser & Strauss,1967). The first observational form identified teacher-centered classroom practices versus the new reform student-centered teaching practices (See Appendix C2). The observational form was used during the analysis of the class videotaped to identify and document what practice the teacher was using frequently the traditional teacher-centered approach or the constructivist student-centered approach.

The second observation form adopted Tolman and Hardy's (1995) five elements that characterizes teaching practices in a science constructivist classroom (see Appendix C3 and C4). This observation form served as a framework to describe in greater detail the tasks set out by the teacher for the students, how the teacher carried out these tasks, and what did the tasks look like in relation to a constructivist classroom supported by technology. The guidelines offered by Tolman and Hardy (1995) were selected because they featured similar elements which are required by the MEQ's reform for elementary science curriculum, such as acknowledgement of a student's prior knowledge, learning requires to be active, and students' need to develop skills to learn to solve problems on their own.

Table 1.0

Coding of positive and negative evaluations (negative referred to a challenge and positive referred to a benefit)

Characteristic	Semantic structure	Example
EVALUATIONS		
Attribute relation	Psychological attribute relation with a *goal or content*	"I'll start that now. Okay" *[goal]* -ATTRIBUTE-*okay* "it fits nicely there" *it*-ATTRIBUTE-'*fits nicely*'
Truth value relation	Equivalence of truth values	"'it collects from DISC-MR each type of element', 'yeah.'" EQUIVALENCE: *[it collects...] [yeah]*
	Qualification of truth value	"'it's defined to both of our satisfactions', 'except it's not just the System Administrator here...'" ADVERS-CONDITIONAL: *[defined...] [except...]*

Table 2.0

Researchers Coding Reliability Test

Line number	Coder 1	Coder 2	Agreement
14	yes	yes	hit
22	yes	yes	hit
33	no	yes	miss
34	yes	yes	hit
34	yes	yes	hit
36	yes	yes	hit
43	yes	yes	hit
48	yes	yes	hit
49	yes	yes	hit
61	yes	no	miss
68	yes	yes	hit
78	yes	yes	hit
78	yes	yes	hit
93	yes	yes	hit
105	yes	yes	hit
120	yes	yes	hit
120	yes	yes	hit
128	yes	yes	hit
130	yes	yes	hit
130	yes	no	miss
132	yes	yes	hit
133	yes	yes	hit
135	yes	yes	hit
148	yes	no	miss
147	yes	yes	hit
152	yes	yes	hit
154	yes	yes	hit
175	yes	yes	hit
182	yes	yes	hit
194	yes	yes	hit
197	yes	yes	hit
204	yes	yes	hit
207	yes	yes	hit
212	yes	yes	hit
223	yes	yes	hit
239	yes	yes	hit
241	yes	no	miss
251	yes	yes	hit

Line number	Coder 1	Coder 2	Agreement
260	yes	yes	hit
261	yes	yes	hit
262	yes	yes	hit
263	yes	yes	hit
265	yes	yes	hit
270	yes	yes	hit
274	yes	yes	hit
281	yes	no	miss
282	yes	yes	hit
288	yes	yes	hit
298	yes	yes	hit
302	yes	yes	hit
303	yes	yes	hit
306	yes	yes	hit
312	yes	no	miss
317	yes	yes	hit
317	yes	yes	hit
323	yes	yes	hit
327	yes	yes	hit
328	yes	yes	hit
337	yes	yes	hit
347	yes	yes	hit
354	yes	yes	hit
365	yes	yes	hit
380	yes	yes	hit
389	yes	yes	hit
391	yes	no	miss
400	yes	no	miss
417	yes	no	miss
418	yes	yes	hit
419	yes	yes	hit
420	yes	no	miss
429	yes	yes	hit
431	yes	yes	hit
439	yes	yes	hit
441	yes	yes	hit
455	yes	yes	hit
458	yes	yes	hit
462	yes	yes	hit
471	yes	yes	hit
485	yes	no	miss
results			67 hits out of 79=84%

Chapter V

RESULTS

Challenges Faced by Teachers in Integrating ICT

Although the two schools differed on many aspects, the data analysis indicates that five common elements emerged as challenges to integrate ICT in a constructivist classroom: lack of professional development; lack of time; technical support; classroom management; and accessibility. Table 3.0.indicates the number of times the teachers have claimed a particular element as a challenge. These challenges are further discussed in the next section.

Professional Development

Lack of professional development emerged as the biggest challenge for teachers. Teachers want to learn about how to use new technologies in their classrooms; however, a lack of opportunities for personal development impeded the teachers from adopting constructivism and technology in certain subject domain. The subject that teachers struggled with was math. Kate said, "I find it really hard to do mathematics on the computer I don't like it." Some teachers said they simply needed someone to show them how to use the software in the course units right when they are going to be teaching it. For instance, one day the pedagogical administration met with Kate for only 20 minutes, showed her some functions on the computer related to math, and immediately Kate went to her class and applied

what she had just learned. Other teachers have said that they basically learn on their own through trial and error.

Although the two school administrations offered a few workshops during pedagogical days or before school hours, most teachers felt that they needed more training over a sustained period of time to support them. Some teachers attended conferences or workshops, but the time between the training and the implementation of computers in their school was too large of a gap. At Montebello, the teachers attended conferences to learn how to use new technologies. However, upon coming back to their school, they would not have computers in their classroom until three years later. By then the teachers had forgotten most, if not all, of what they had learned. Furthermore, technology changes very quickly, so what the teachers were exposed at the conference would have changed three years later.

Even if the administration at both schools supported the integration of new technologies in the classroom, much of the training and the research into which software or program to use was left up to individual teacher initiative. Mary at Montebello, described how the administration did not provide her with more support.

> Mary: "... I was pretty confident in my ability to learn quickly about the stuff I needed to know about the laptop and I was just throwing myself in the deep end so I just went, "Oh, ok, just try"—because when I came in they said, " Just try and use as much of the technology as you can. Try and work it in." So, I just sat and tried to work it in as much as I could and found that in some ways it worked really well and in some ways it was maybe better if I did it another way."
>
> Researcher: "Ok."

Table 3.0

Challenges in integrating ICT in classroom (each count is the number of times a positive evaluation of a theme was mentioned by a teacher during a one hour interview).

Theme	Jorge	Mike	Kate	Mary	Dan	Francine	Total
1. Lack of personal development or skills how to design or evaluate constructivism learning situation	9	6	29	18	2	1	65
2. Lack of time	6	1	18	4	15		44
3. Technical problems	4		8	1	7	3	23
4. Classroom management			12	1	1	2	16
5. Accessibility to the computers/smartboards	1		8	3	2		14
6. Finding ways to make it interesting for students			5	1			6
7. Students typing skill low	3						3
8. Lack of initiative from teachers			1				1
Total	23	7	81	28	27	6	172

> Mary: "Yeah I was just throwing myself in the deep end when it came to preparing... So, it was a matter of search and discovery last year... With this year as well."

Windschitl and Sahl (2002) found that teachers learned about technology use from peers and teachers in other laptop programs. From the teachers interviews, in this study, teachers explained how they do learn from their peers and work jointly on projects; however, at times it can appear as the blind leading the blind. For example; at Montebello three math teachers, Mike, Kate, and Mary, worked on a joint project. Mike possessed a mastery level knowledge of computers, but the other two teachers were less comfortable with ICT. For a math course, Mike had designed an activity for a unit on probability and ratio with the purpose of integrating ICT and creating a situated learning environment. In other words, he had planned a unit to adopt the new government reform. Kate and Mary tended to work in isolation during the school year; but when they were approached by Mike to work together on this project they quickly embarked on the joint project.

All three teachers confirmed that neither they nor the students learned any new technology. Kate and Mary explained that no technology was used by them to teach the unit. Their students simply used the software PowerPoint to make their presentation, as well as the software Word to write their report. All three teachers explain how technology was used in the project.

> Researcher: " Ok. How is technology involved in that? "
>
> Mike: "Yes. A lot of things. A lot of the research was done on line. A lot of research that the kids did. A lot of the presentations were generated by the computer. They all have their own laptops so, that's really sort of where the technology fit in at least in my classroom."

Mary: "Same with mine."

Kate: " Yeah. Getting information and a little bit in the presentation part because they ended up doing, almost every group in my class did a PowerPoint presentation where they presented the information to the rest of the class cause that was part of the requirement, was to not only write a short report on it but also to make a presentation to the class. So, (to Kelly) and I think quite a few kids in your class used PowerPoint too?"

Mary: " All groups did [a PowerPoint presentation]."

Kate: "All groups… [did a PowerPoint presentation?"

Mike: "2 out of the 5 used PowerPoint. One of them did just very specialized research for the other groups and one group was supposed to generate a movie although to date I haven't seen it. which, doesn't go well. And the final group was sort of the poster, pamphlet group so they, most of their stuff was done by hand."

Researcher: "So when you were putting this project together, were you learning any new software or not?"

Mike: "The kids were not."

Researcher: " What about you?"

Mike: "Personally, no."

Mary: " No."

Kate: " No."

The teachers at Montebello were all well equipped with the latest technology, and on the surface they appeared like everyone was adopting the new educational reform in their classrooms just fine. Teachers were beginning to find some time to get together to meet and plan situated learning lessons. However, the teachers struggled with the understanding of what constructivism was and how to make changes in their teaching practices that would adopt the new teaching

standards. This was evident when they addressed a question how their teaching practices differed from traditional teaching.

> Kate: " Yeah. I don't know if...it definitely wasn't teacher-centered. I don't know if I could call it student-centered, but it wasn't teacher-centered let's put it that way. Yeah, I really just let them...and they could do whatever they wanted. Like there were no guidelines."
>
> Mike: " That's an excellent question. For my own part, I think too much of it was somewhat traditional teaching. I think that I had a lot of trouble stepping back and letting the boys do the work. You know, the amount of, again, when I do this again, the amount of pre-teaching that I do will be considerably less. We did a whole unit before on ratios and proportions and so on and so forth..."

Lack of Time

The second most common challenge reported by all the teachers was the lack of time they had. They did not have enough time to plan outstanding technology lesson plans, or explore the different aspects of World Wide Web or software. All teachers interviewed commented that how it took much more time to design projects that included the use of new technologies than to prepare lessons for the traditional way of teaching with books and handouts.

Teachers found that the constraints of different class schedule contributed to the lack of time they spent together to work on planning classroom activities. Ultimately, if this barrier is not addressed, how the new technology is used in the classroom will lay in the hands of individual teachers. Here is what Mike, Kate and Mary had to say about their joint project on planning a unit on probability and ratio with the use of ICT:

Mike: "... in hindsight I think we needed more sort of planning time at the beginning to sort of go through it. it's the first time we've really done this kind of project. It's the first time I've really done a project that sort of, I've designed and then brought [it] and said, "Here!" So, I didn't even know what I needed to say and what I didn't need to say and so I think also being physically separated from each other, I teach across the street, makes it harder..."

Mary: "[We] had to track him [Mike] down."

Mike: "Track me down or have to send it by email and then you have to figure out how you can say it in an email, how are you going to ask the question you need to ask in an email, and then you know, for my part when I explain things it's sort of, I know what I want for me personally but that might not work in everyone's classroom so I give you as broad as a description as I can and then take it any way you want. For some people that works well, and for other people it doesn't so, it's a question of being able to work in a group and having the time to be able to meet and discuss the things you need to discuss and sort of being able to hold it all together."

Researcher: "So how much time would you say you spent on it?"

Mike: "About one meeting on it or on doing the project...maybe half an hour the three of us together."

Kate: "No more than an hour. Cause the initial meeting was maybe 20- 25 minutes and then we met at lunch once. That was the hard part, was just we said afterwards like, would be much better if we had 2 or 3 hours just to plan it out. This is how we're going about doing it. and that was the other thing, at least I felt, is that I was constantly, I was sometimes even deciding after the fact how I was going to evaluate...I was working in a completely backward direction just probably because we hadn't discussed enough because it wasn't an idea initiated by me, so I just had to think ok, well, it was just kind of constantly picking up the pieces after the fact so."

The lack of time proved to be more of a challenge for teachers who were less comfortable with computers. It was time consuming to find better software or

ICT hardware that would compliment their lesson plan. They complained about how long it took to first find the software and then learn it in time for the class. Kate tells us, "[I'm] responsible for teaching 25 to 30 hours a week, grade over 60 papers and tests, and prepare for classes I cannot afford to give any substantial time to personal development or designing curriculum with technology". When they did try to learn a software and integrate it into the class it took so much effort to do it that they had to put extra hours in grading papers and playing catch up games with their schedule. Eventually they reverted to the didactic way of teaching.

One would also think that if all the students had their own computer, and no set-up time was required prior to classes, there would be enough time to complete the entire lesson plan in one period. But the findings in this study showed that whether a teacher was new to teaching or possessed more than 20 years of experience, all said that there was not enough time to cover all of the MEQ educational requirement in the school year when a constructivist approach is taken, and more so when technology is being used by the students.

Technical Support

Technical problems were a major obstacle for teachers. It was frustrating for the teachers at Mont Laurier when such events occurred; waiting for a website to pop-up; failing to connect to the Internet; printers not printing, malfunctioning computers, and teachers had to work on old computers. In those instances, technical barriers impeded the smooth delivery of the lesson or the natural flow of the classroom activity.

The Laurier Wilfrid School Board provided minimal technical support to their schools. Therefore, at Mont Laurier, technicians were scarce and the students and teachers bore the consequences. There was only one technician for forty-five to fifty schools, and she did not have enough time to stay on top of the daily technical problems. To work around this difficulty, both teachers interviewed resorted to asking for help from fellow teachers, or they became technicians themselves. Time spent troubleshooting problems meant valuable class time was lost, or in most cases, the technology was not used at all. Dan explained how a malfunctioning computer resulted in an unused machine for almost an entire school year.

> Dan: "... we have nine machines, well actually we have eight now because one is out to be fixed."
>
> Researcher ...computer's out to get fixed. How long ago was it sent out?
>
> Dan: "It's terrible. It was sent out...it was flagged in November and I spoke to the technician, I wrote it in using the system the board has set up for us, I wrote it in her book and she came in and saw it and said, 'Don't send it down to the office until I give you the signal.' So it stayed there about four months in the classroom. So, finally I was able to speak to the technician about a week ago and said, "When are you going to get around to fixing this machine?" and she said, "oh, you can take it down now to the office." So, I think that was two weeks ago. It's still there ready to go out. [this is the month of May]"

In the private school, although funding was not an issue, going wireless meant a logistical nightmare, particularly with software and hardware incompatibility, and connecting to an incompatible server. All 7th through 10th

graders having a laptop meant three hundred and fifty more students were able to simultaneously download large files, causing the spreading of viruses and crashing hardware. In the first year, Montebello had one and a half technicians supporting the teachers and they found that was not sufficient, they increased it to two full-time, and still more technical support was required. In the coming fall, the beginning of the school year, the 11^{th} graders will be embarking on the laptop program meaning sixty additional computers to purchase, configure, and provide maintenance for. The school will hire the part-time technician to work full-time.

Other than the need for more technical support, the technical procedures carried out by technicians proved to be a challenge for some teachers. The overall time it took to manage technical problems took time away from classroom period. One reason for the lengthy time to deal with technical problems was that there was a lack of clear procedures between the technical staff and the teachers. For instance, when a student's laptop was non-functional a "loaner" computer was provided for the day. At the end of the day the laptop was returned to the student. However, Jorge, the science teacher, described how the task of taking the computer away from the student and giving him another one was not working efficiently as he would like. Although, students were sent to the technicians to get the loaner, the technicians often tried to fix the malfunctioning one on the spot, with the consequence of taking class time away from the student. This was frustrating even for the most enthusiastic and keenest teachers, such as Jorge. This is how what he described it.

> Jorge: " ...I'd like the lab technicians to be more efficient. He comes in 90 second to 2 minutes, 'this is not something I can fix. Here is your loaner.' Rather than the 5 to 10 minute wait because now the kids are late back to class...and a lot of the times, the problems in the computers are the youngsters have done something that put the machine at risk and caused the failure, and caused the...you know, downloading Kaza would be a good example. I don't think we should be tolerating or wasting our resources fixing that while the student waits. Give them the loaner, they don't like loaners...it's not their own machine and come back, it's going to be re-imaged. ...I think we've got room to get better there. But it's not a very hard to do things, I already know. I think that's somewhere we need to get a little better."

Computers need to be upgraded from time to time. Equipment like laptops may look Hi-Tech for a school; however, they age and become outdated. Mary, at Montebello told us her frustration with an old laptop.

> Mary: " ...I was working on an older laptop that, I didn't have the sort of connections available and there was a lot of preparation ahead of time to get it sorted out so, I probably didn't us it as much last year due to this fact.

When students own their own laptops, teachers have described how some technical problems have decreased. A reason may be that there was only one student using the computer and it belonged to him personally. Students became responsible for their own computer and were required to deal with the technician directly if it was not functioning. However, when the computers were rolled into the class by the teacher or technician they were not being used by the same student or the same class. There were as many as two to three hundred different students

using the same computer at Montebello. Kate shared her frustration with cart computers.

> Kate: "Like the cart would drive me insane… I never, I very, very barely used the cart I have to say. If I used technology at all before, it was my laptop, the smart board, but I just, I found the cart completely inefficient getting them, some of them be— some of them wouldn't open, some of them wouldn't' t close, some of them had no power. It was all just more management again. It's just—it drove me insane. The fact that the kids just have their own and because their—I don't know exactly what their level of responsibility is for the—for how cleaned up they are or whatever the computers are but at least if something is wrong I say, 'Hey. It's your laptop. Take it to the tech. If yours isn't working you should have dealt with this." It's not like I'm giving them #27 from the cart, they go, "#27 never works, I don't like this one." They have their own and if they want it to be working and if they want it to be effective in class, then they know they have to go and see the techs and get it sorted out before hand. And I just feel like it's a lot easier to—they have better control over their computer and how it's working and if it's, you know, if it's bogged down with some kind of a, I don't know, a virus, but whatever. You're basically making them responsible and it's much better that way.

Classroom Management

Traditional classroom set-up was that of a well-arranged row of desks with the teacher in the front and the students sitting quietly. However, teaching through projects and teaching using computers demands that the traditional arrangement change, for example to using round tables or desks clustered together. This structural change alone proved to be challenging for teachers.

> Mary: "I would have liked to receive some form of training on how to manage the set-up of the classroom. It was difficult for me at first to know where to sit with my laptop so that I could have the ability to look at the screen of the students and keep control of the classroom".

Teachers felt it was necessary to see what the students had on their screen when teaching. This gave them some sense of control. In fact, how to keep control of the classroom was a major issue for Kate, the teacher which was the least comfortable with technology.

> Kate: That's my biggest problem with it. And that's one of the reasons why I get frustrated when, let's say I send them a document and have them, say, "Ok. Let's all look at them together." .... You know if you're not in the right position in the classroom, if you're at the front kind of working on the board and showing them a few things while they're going through it, you can guarantee that out of the 15 kids in the class, 4 of them are off somewhere else and I find that very frustrating. So sometimes I don't even let them know that it's in their file. I just show them on the projector what I've got up on my computer. And I almost don't let them even open their computers until the end of class because I find it so frustrating to manage who's really on task and who isn't.

As teachers moved towards more ICT usage in their pedagogy they experienced difficulty with controlling the information students had access to. For example, a tool like the Internet opened the classroom to the world, permitting students to download all kinds of information and games. Teachers claimed that they could not easily control what information students accessed, how students behaved online, and whether students stayed on task during class time. These issues were causing more frustration for teachers compared to a traditional classroom where students were exposed only to the books and worksheets assigned to them. Kate described her frustration with classroom management with each student owning a laptop.

> Researcher: " What would be the difference, someone's either emailing someone or flipping back and forth with their computer compared to a

> classroom where there are no computers, and are they doing something else? They may be daydreaming and not listening to you."
>
> Kate: " Yeah. It's not that—it's just that sometimes it's just if they don't have another distraction, then it's just easy for them to listen to you. Yeah, they can certainly tune out and you can tell, you know, when they're tuned out too, you know whether they're doodling or flipping through their agenda. It doesn't have to be computers, for sure. But, it's just, it's just a ready distraction that's right there and so normally if I'm having them do something, I can say, "Close you're your History book. This is Math class." And their history book is open and they put it away. But with the computer I would feel like there's—it's like having a page open in a book but they can change that page without me seeing it kind of thing. And they're all still looking at the screen and their 2 friends behind them are looking like this, (demonstrating), "Look what he's got on his screen there." So, so yeah, there's—it's not that they're doing anything different than they would have done, it's just that it's so easy for them to have access to something that they're not concentrating on and for them to say, "No, I was looking at the Math." They just 'click' and there it is."

Other than the ability to control information teachers faced a challenge with making sure the students were working on the activity assigned to them when they were working on projects. Particularly, if they were walking around the class, talking to their classmates in their groups or outside of their group. Kate said, "you can guarantee that out of the fifteen kids in class four of them are off somewhere else and I find that very frustrating …and I almost don't let them even open their computer until the end of class because I find it so frustrating to manage who is on task and who isn't ".

Accessibility

Accessibility is another factor that dampened teachers' enthusiasm to use any piece of technology, such as a computer, a smart board on wheels, or a video

camera. Prior to going wireless, teachers at Montebello complained how difficult it was to always have access to the computers on carts. Computers had to be booked in advance and the teachers would forget to do so, or they could not book them for several periods in a row when they wanted to work on several projects with the students. Because most of the resources were shared there would always be someone who would not have access. The problem has decreased for the 11th grade teachers because they are the only ones currently using the cart computers.

Mont Laurier School experienced even more accessibility problems. Not having enough printers was a problem since there was only one for several classes. Quite a few teachers talked about the difficulties of having only one online computer in the classroom. They dealt with the problem by rotating the students and by giving students time during lunch hour to use the computer. Another teacher circumvented the problem of access by asking her students to do the online research at home. But that option did not work well because not all students possessed a computer at home, so once again the teachers created a schedule to make sure that all students had some computer time, and created groups that would work on the same computer for the duration of a project. Dan disclosed that since three or fours students shared the same computer they each, "rush through their work and do a mediocre job just so they can finish up their work in class."

Benefits Faced by Teachers in Integrating ICT

The data analysis indicates that five common elements emerged as benefits when ICT was integrated in the classroom: As seen in Table 4.0 they are: Sharing of information, communication, editing, monitoring, and web access. Table 4.0 presents the number of times the teachers had claimed a particular element as a benefit.

Teachers who had little ICT knowledge mentioned just about the same benefits as the teachers who were comfortable with computers and technology. Kate, the math teacher who used ICT the least and was not always keen in adopting new software in the classroom, was the teacher who had the most good things to say about how ICT had a positive change in her classroom. Following her was Mary, the other math teacher who also found it hard to use technology in math curriculum. She too had good things to say about the benefits of ICT in a constructivist classroom environment.

Sharing of Information

According to the teachers, *sharing of information* was the greatest benefit that ICT contributed to a constructivist classroom. A tool that teachers at Montebello really found easy and rewarding to use for demonstration and sharing information was the Smartboard. The Smartboard is a presentation device that interfaces with a computer. What they particularly liked about this device was how the documents or images they had on their computer could be displayed on the

Table 4.0

Benefis in integrating ICT in classroom (each count is the number of times a positive evaluation of a theme was mentioned by a teacher during a one hour interview).

Benefits	Jorge	Mike	Kate	Mary	Dan	Francine	Total
1. Sharing of information	3		21	5			29
2. Communication with students and parents	1		12			2	25
3. Ease of editing			11	5	4	1	21
4. Monitoring students			5		2	3	10
5. Access to website information			1	2			4
Total	4		50	12	6	3	89

board, so that, the information was seen by the entire class. The teachers could also manipulate the device by adding notations with the use of a pen and or highlighter tool. The notes or drawings were then saved, printed out, or distributed on to the students' conference.

Jorge described how he was able to recruit parents to help their children with their mathematics homework. Parents were able to access the teachers' class notes daily on the conference where they could retrieve all the information their children received that day in class.

> Jorge: "...I think the big benefit is when the parents are working on algebra at home with their youngster at which are very rusty, ... They open the notes for the lesson plan. They see, oh! I know that! And then they teach it exactly the way I've taught it.

Emailing on the conference made it easy for the students at Montebello to share information and work in groups without being physically together in the class. Students were able to continue to work on projects from the comfort of their home. Of course, this was possible for these students because they all owned a laptop. Kate describes how her students used the laptop to share information.

> Kate"... But one thing is I do find that it's a lot easier for them to share information, which I do like. You know if they've come up with a word problem, one assignment I did was have them come up with a word problem. They had to email it to a friend that night and have each other solve it, which normally I wouldn't have done because they would have written up the word problem and then to have them say it to have to call a friend and do it, it should just be easier for them to see it, so when they get their email from their friend, they can solve it. So, yeah, a little more collaborative, which you know, I wouldn't have done something like that without computers before hand.

Communication

ICT has provided an open channel of communication between teachers and students, teachers and parents, and between teachers themselves. The email feature has made for easy and timely contact with others. Kate explained her use of email to communicate with students.

> Kate: "That's one thing I love about it… one thing I'm really using a lot is communicating with them via their computers. I just find it—it's really easy to give reminders, it's easy to distribute homework, it's easy to get in touch with individual students about particular problems. I'm not on it at night, but sometimes I'll come in the morning and it will be a student saying, "I'm working on my homework at 8 o'clock, I have a problem." Well, I'm not on at 8 o'clock. I very rarely go on at night, so I can't answer those questions immediately for them. But at least I know in the morning, "Oh, Justin had a problem last night, that's something I can address right away."

Monitoring Students

A teacher does not need to be a wizard at technology to use it for monitoring students' academic performance. The email feature provided teachers with the flexibility to stay on top of their students, particularly with students who required more attention. Kate explained how she used it as a reporting system with her weak students.

> K Yeah. Yeah. That's—the email's terrific for that. I really, I really use that a lot actually… Almost on a daily basis. Even I've got a couple of students who are on a kind of regular report because they're really not doing well. And I just keep them on a—I make kind of a general, "This is what we did today. Reminder: this is what your homework is." And I sent it out to these 3 or 4 kids. They constantly get a "Oh, yeah." Just to remind them what's going on.
>
> C Ok.

> K So, for me that's a real bonus. Rather than chasing them around individually, it just makes it so much easier. And also there is that kind of confirmation that, "Yeah, I did tell you. I'm certain of it. Let's look back. Oh, yeah. I sent you an email. And you read it at 7 o'clock and again at 8 o'clock." So, I like that too. Just having a bit of a check on them where they can't say, "Oh, I didn't get that. I didn't." "In fact you did!"

Editing

Another benefit is the ability to edit documentations Francine described how she had received a lesson exercise from another teacher and she wanted to modify it. She found it to be fast and easy to do, whereas, in the past she had to distribute the documentation as it was or take the time to recopy everything.

Editing has also made the teachers' presentations and class material clearer and more attractive looking for students.

> Dan: "But you know, one thing I really found valuable with computers is for my own work when I'm doing stencils and tests and writing up activities is it's revolutionized what I do...And when you keep things, it is easy to pick it up the next year and modify it... For documentation purposes, if you can't find a... in the past you had to write everything down, keep it in a folder. And if you want hat folder you can't find it... at least now with the computer it's fantastic... So when I do a field trip and I need a permission letter, I just get out last year's field trip letter and I just change the dates and anything else. It really helps me with the public speaking contest recently. I had t have a sort of schedule showing the students and their topics. And I just picked up last year's and I just changed the names and the activities where the same and everything else. It really speeded it up."

Access to Website

Accessibility to the web provided supplement classroom training material for teachers. What teachers liked about the web is the ability to find creative lesson plans for certain subject matter. Mary explained, "I was able to use certain things that I found on the Internet that would help kids learn different Math subjects..."

At Montebello School the students used the web a great deal to conduct research, particularly during the project based activities. When students wanted to learn more about a topic they were directed by their teachers to go on-line and search for the information.

A look at Jorge's constructivist teaching practices supported by ICT

Classroom Appearance and Activity

When individuals walk into Jorge's classroom they are introduced to a large science lab. There are large windows and lots of counter space, boxes filled with minerals, rocks, electrical equipment, lockers which serve as storage space under lock and key. Display counters, smart board, printer, laptop projector and lots of space for students to move around freely. The room is furnished with tables which seat three to four students together, and a large counter for the teacher which he uses as a desk, to hold his laptop, class printer and various paper files and school supplies.

The particular classes that were observed covered the unit on sensor programming. The unit was covered in seven lessons for periods of 75 minutes each. On the first day of the unit, Jorge explained to the student what they were required to work on during the next seven classes. The six main tasks, which the students would have to complete in the unit, are presented in Table 5.0.

Before initiating the activity, the students were instructed to form groups of three and take one of the following roles: Programmer, project manager, and builder. Each day the students rotated roles. The role of the programmer was to code the programming language that would manipulate the robot; the project manager was responsible for keeping the team on track, documenting the status of the team and emailing it to Jorge at the end of class; and lastly, the builder was responsible for building the robot using Lego Blocks.

In the next section, using Tolman and Hardy's (1995) five elements of teaching practices in a science constructivist classroom (see Appendix C3), Jorge's teaching practices is described in detail.

Table 5.0

Remote sensing tasks

Task	Activity
Task 1	Get the students to download the MicroWorld software.
Task 2	Build a vehicle robot with wheels using Lego Blocks
Task 3	Create a small programming script to get the robot to climb a 5 % hill.
Task 4	Readjust the program and add a light sensor in order to get the robot to climb a 5 % hill, hit the black line and return back down backwards.
Task 5	Readjust the program again so that the robot not only climbs the hill but makes angle turns, particularly a 30^{o} angle turn and move down the hill.
Task 6	Readjust the program so that the robot climbs the hill, makes a 30^{o} angle turn and comes back down the hill and stops at a designated white line.

Activating prior knowledge

Jorge had recently ordered the software program, MicroWorld, which he was planning to integrate with this unit. He did not have enough time to test it but he would have just the same tried to use it with the students. On the first day, lesson one of the unit, there were three particular pieces of knowledge and skill that students needed to possess and Jorge needed to consider prior to starting on Task 1, 2 and 3. First, the students' needed to have the ability to download software onto their laptop. Second, use Lego Blocks to build a robot. And third, the students had to have some ability to program in the basic language.

Jorge began the unit with a discussion with his students on what would take place in the next seven classes. His intention was to learn how much students remembered and knew, and understood about the required knowledge and skill. Having done that he learned that the students all remembered what it was like to play and build things with Legos, and to download the software on their laptop; but he ran into a problem with the students' knowledge of programming. Jorge had assumed that students had all learned programming the year prior, but in fact, less than half the students knew anything about this topic.

Acquire knowledge

That same day, still on lesson 1, once Jorge had evaluated the students' level of existing knowledge of programming and realized that their knowledge was little to none at all, he began building on what they knew. However, a problem occurred. He asked the students to download the MicroWorld software onto their

laptop, but due to technological complication they were unable to do so. After the initial try to get the software downloaded on the students' computers, Jorge tried again on his own to sort out the problem but he was unsuccessful in getting the software to function. He did not ask the technical staff to assist him nor the pedagogical resource person because of the urgency in starting the unit. He quickly decided to go ahead with the lessons without the use of MicroWorld.

As for the students' lack of programming knowledge, he did not ignore that and immediately took action, which is explained in the next section. Through further dialogue with the class he was able to learn and evaluate that two boys really needed no explanation on the topic and would be ready to go and work on Task 3, which was to, *create a small programming script to get the robot to climb a 5 % hill*. However, the remaining eighteen students had either no prior knowledge or some small recollection from the prior year. Jorge reacted quickly to the situation and progressed to the next level of *Understand Knowledge*, in order to get the students to learn how to program.

Understanding knowledge

In order for the students to understand how to program in the basic language Jorge used different approaches. First, he emailed to each student a document explaining what programming was and a sample of a small written out program. He asked the students to access the documents and read chapters 1 to 5 before the next class. Students had several days to read up on the topic. Second, he asked one of the two boys in the class, who was very knowledgeable on how to program in basic

language, to give a demonstration with PowerPoint software. The objective of the presentation was to show the class how programming is done. He then asked the boy to email the information to his classmates so that everyone would have access (on day two, the boy gave the presentation to the class). Third, Jorge pulled up some files from his laptop which projected on the smart board, and simultaneously he took out his chalk and went on the black board and began explaining what was programming language and how to create a program.

Jorge spent approximately twenty minutes explaining programming and then he led the students into the next step, which was to use the new knowledge they had just acquired. He asked them to get into their groups of three and work on task 2 which was *building the robot* and task 3 which was *to create a program*.

Using knowledge

Jorge guided students by having each one select the role they wanted to have that day, project manager, builder, or programmer. The students decided for themselves which role they would take on. In all the groups observed the boy who was most comfortable with programming was the first to take on the role of programming. The builder was the role which most students had no difficulty doing because they were using their prior knowledge in the context of what they already had learned from their childhood.

Not knowing how to program did not discourage the students from working on the task. Instead of being moved through material at a predetermined pace, they learned from their teammates, and through the group work they problem-solved

through their task activity. Although each student had a designated role, all three students in the group shared ideas and suggestions on how to do things. For example, one student said to his teammate, " ...try this top so the robot is bigger." Even role responsibilities were shared, " You get the box [of Legos pieces] organized, get the wheels together, and the other pieces in one side."

All of Jorge's lessons began the same way. The period began with students walking to their table and placing their laptop on top, and then they walked over to the cupboard (opened by Jorge before they walk in) and they got their robot vehicle and began working with their team on their task where they left off the day before. Only after ten minutes into the class did Jorge ask for everyone's attention. All the students then returned to their seats and listened to what Jorge had to say. This practice was very familiar to students and they were quiet at that point. Jorge asked the students where they were with their tasks and then gave them guidance on what task they should be moving toward that period, and if they finished that particular task they could move on to the next one, which he explained briefly. Quickly the boys got to work with their team.

Jorge encouraged them to work independently with their team and classmates and not to rely on him, thereby empowering the students and giving them more autonomy. At times students were so eager to help others classmates with their problems that the teacher had to pull them away and say, for example, " Okay Paul, leave group 4 alone and let them figure it out themselves ... thanks for helping." Students were observed looking over their peers' shoulders, commenting

on each other's work, offering assistance, and discussing what they were doing or making suggestion on how to complete their task.

Some of the decisions the students had to make were what type of robot they wanted to build and what kind of wheels would it need. Those decisions were important because at the beginning of the school year one of the topics was friction on different surfaces. As they were modifying their language programs between Task 3 to 6, many teams would decide to change the structure of their robot. They were exploring how different structures handled the different programs.

One looking in from the outside might describe Jorge's class as loud and chaotic and out of control. Some students were walking around, some sitting in front of their laptop and lots of chatting between themselves. Jorge permitted students to walk around and talk to members of other teams so they could hypothesize, question, and investigate. Once students were exposed to the new idea of building and programming together, the process of understanding the knowledge was reinforced through the hands on activities. Another way students reinforced their knowledge was to share it through conferencing. Jorge would also reinforce this by reminding students to share and to seek information on the conference if they were having difficulty.

Jorge was also walking around the class, going over to students table and talking to them about their activity. He would go by a group's desk and ask them where they were and probed them, "Are you sure those wheels are good for that surface?" "Did you go on the conference and see what other groups have done for their program?" And he would stop and sit with students who he classified as

"having trouble." What Jorge was doing as a teacher was seeing how well students were using their newly acquired knowledge.

When the students completed Task 3 they quickly moved on to Task 4, 5 and 6 independently, and they began once again working through the problems by using the collective knowledge of their teams and classmates. Some groups moved through the tasks more quickly than others. But, at the end, all the groups completed all of their assigned tasks.

Reflection

During each class period, the team had to write a log, and email it to Jorge, on what they did that period and how far they got, and how well they were doing. It was useful as a monitoring device for Jorge to keep track of which task the students were working on. A copy of complete logs from a group of students can be seen in Appendix D1. This process allowed Jorge to get immediate feedback on where groups were at in relation to their tasks and also to identify students who were slower and having difficulties. The next day he would spend time with those students or he would send them an email with questions to trigger other ideas to try that day.

During each class period, Jorge would call over those students who were project managers for the day and spend no more than five minutes with them. He would question them on how their team was doing, and, if the team was not doing well, to go on the conference and find out what others were doing. He would remind them that it was their responsibility to keep the team on track and document

what they were doing. The boys would immediately return to their table and begin writing their logs.

Analysis of Jorge's Constructivist Teaching Practices Supported by ICT

Jorge can be considered a constructivist teacher. He has redesigned the lessons from a teacher-centred approach to a student-centred approach where he took on the role of facilitator rather than the owner of knowledge. He offered his students options and choices while they were engaging in their classroom activities. But being a constructivist teacher is not easy, as Jorge stated, "It takes a lot out of me, it would so much easier to tell them what to do and leave it at that," "It is exhausting."

During the classroom activities, the technologies Jorge used for teaching and learning were documented (see Table 6.0). We found that both he and the students were very comfortable using conferencing as part of their everyday classroom activity. Students were also showing no reservation in using the laptops.

Table 6.0

ICT adopted with classroom activity

Task	*Activity*	*ICT Tool Used by Student*	*ICT Tool Used by Teacher*
Task 1	Get the students to download the MicroWorld software.	Laptop conferencing	Laptop conferencing
Task 2	Build a vehicle robot with wheels using Lego Blocks	None	None
Task 3	Create a small programming script to get the robot to climb a 5 % hill.	Laptop Basic programming language Powerpoint Conferencing Word software	Laptop Conferencing Smartboard
Task 4	Readjust the program and add a light sensor in order to get the robot to climb a 5 % hill, hit the black line and return back down backwards.	Laptop Basic programming language Conferencing Word software	Laptop Conferencing Smartboard
Task 5	Readjust the program again so that the robot not only climbs the hill but makes angle turns, particularly a 30^{o} angle turn and moves down the hill.	Laptop Basic programming language Conferencing Word software	Laptop Conferencing
Task 6	Readjust the program so that the robot climbs the hill, makes a 30^{o} angle turn and comes back down the hill and stops at a designated white line.	Laptop Basic programming language Conferencing Word software	Laptop Conferencing

All the logs from the students were completed using Word software and then emailed to Jorge. In fact, most students did not have a pen, pencil or paper on their tables.

Jorge's laptop was open at all time during class time. From time to time, in between his walks from group to group he would go over to his laptop verify what students put on the conference, read emails, and even sent the researchers videotaping documentation, such as class list and schedules.

Although Jorge is a savvy computer user and programmer, findings tell us that he needed more guidance on how to use the technology to improve student learning. He knows very well how to develop lesson plans and use the technology independently. He is also not afraid to introduce a new software to the class even if he does not know it very well. However, he is not completely sure of himself in designing an entire curricula combining the two characteristics together that fits with the demands that are imposed on him by the reform. This became evident during our observation and videotaping when he would ask us:

> Jorge: "If you know anyone else who is using MicroWorld in programming I would like to hear how they are using it… Are there any other schools that are doing what we are… I would like to know what others are doing with it…If you have any suggestions I am willing to hear them. If you feel I am not doing this correctly please tell me."

Jorge searched for guidance from the researchers on how to teach with the new software for the following year. He independently designed his own lesson

plan because there was a lack of guidance or manuals from the school administration or the MEQ guideline. Jorge had access to a pedagogical administrator but did not seek assistance from this resources nor other teachers. The attempt of introducing MicroWorld in the unit without any training or support, and having it fail indicates that Jorge's teaching practices supported by technology is based partly on trial and error and experimenting on his own.

Chapter VI

Discussion

This study sought out to answer the following questions:

- What are the current challenges and benefits impacting teachers with the integration of ICT in the classroom environment?
- What do teachers' practices look like given a) in the context of Quebec's constructivist learning environment and b) supported by technology?

A discussion on the findings to the questions is presented in this section.

ICT Challenges and Benefits in Education

It is obvious that technical problems will occur in schools when there is an increase of ICT. The difference is what kind of technical support and access do teaching staff have. Whether a teacher has twenty years of experience or a novice to the profession, technical issues create barriers to the smooth delivery of lessons. A

poor technical plan and insufficient technical resources generate constant interruption and time away from teaching and learning. Therefore, to the extent that on site technical support is not available, greater training for teachers is required to develop troubleshooting skills.

Participation in classroom learning activities utilizing ICT tools tended to be greater among teachers with more technology skills than those with less skills. Part of the reason is that teachers are responsible for their professional development and are expected to learn about software, hardware, and on line resources on their own time. The lecture and drill methods many learned in university are no longer adequate, today more time is required to design and research new lessons for a constructivist classroom supported by technology. Teachers have to search for the right computer software and hardware or even explore already designed curriculum on the web and then learn it.

When teacher training is available, it is not an on going practice and sometimes there is too much time between the training and the implementation period for the teachers to remember what they have learned. An effective way to acquire ICT knowledge is to have teachers work closely with colleagues and to share responsibilities or have an exchange of ideas. Teachers are not against the idea of collaborating together on ICT joint teaching projects but their schedule and workload do not make it easy for them to share pedagogical expertise and harmonize their efforts. Schools, like Montebello did send one of their teachers on a training course. When he came back he did not keep the new knowledge to himself but shared it with two other colleagues. Distributing the

knowledge amongst teachers is an option worthwhile considering, particularly for any school working with limited funding, and unable to send all staff on training.

Professional development efforts are often ineffective because training takes place away from the school site and there is a lack of follow-up and support. In order for professional development to be effective, in class-assistance and support must be provided, and it must be context specific. A professional development program design, to help teachers effectively integrate technology into their classrooms, should include an introduction and demonstration of a computer application, hands-on activities, and collaborative work amongst the teachers, continued with a discussion of the implications the application had on teaching and learning and finally in-class support during technology enhanced lessons. Alignment with the school context and relevance of workshop activities is also crucial. By having teachers bring experiences from their classrooms to professional development workshops and by ensuring activities are directly aligned to curriculum goals teachers would then see a greater relevance for integration of ICT into their classrooms.

New technologies change the dynamics in the classroom and for some teachers it appears more difficult to control. Issues with class management include how do teachers know if students stay on task, how do they control what information students are being exposed to? Having new technologies means having the world enter the classroom, the teacher now has access to many more sources of information, but also has to manage that information. Prior to the World Wide Web

it was easy with only books to manage, but a teacher today has to teach students how to become more critical with the information they find and how to organize it.

Overseeing if all students are on task and learning the new knowledge can be a challenge for teachers. With the great features of new software, it is possible for students to get so caught up on elements such as type of font or audio clips, colors, graphics that they pay less attention to the substantive content of their activity. One of the teachers who worked on the joint project on probability theory said, " They [the students] did not get it [implying the lesson content]... the most part of the activity was spent on creating and editing the computer graphics on their PowerPoint presentation." Teachers need to develop strategies to make sure that students do not get distracted by some of the more enticing but less substantive features of technology.

Another element which is often over looked is the physical class size and layout. New technologies change the set-up of the classroom. The classic teacher-centered set-up is now replaced by a classroom where there is space for computers and other new technologies, and where desks are replaced by tables grouped together to foster group work. In the private school, Montebello, there was lots of room for students to walk around and move about with their computers. Students moved freely behind and in front of the teachers desk and they had room to set up the platform to conduct their robotic testing. In the public school, Mont Laurier, it was evident that the eight computers in the class tightened the space making it difficult for students and the teacher to walk around freely to create activities where they could move from group to group with out walking into each other.

Although teachers do experience challenges with adopting ICT in the classrooms they continue to be optimistic. They can see the benefits of using technology like the email, various graphic software, the Smartboard, and on-line information. Teachers see how their materials are clearer and more interesting visually for students because of editing features. They can access creative programs on the web on various subjects which they can incorporate in their lesson plan.

Constructivist teachers' practices supported by technology

Constructivist teaching practices appear different from the traditional classroom. One reason is that the role of the teacher changes. Constructivist teaching is less about the sequence of events and more about responding to the needs of a situation. Clearly this new role requires a teacher to be flexible and more comfortable when things do not go as planned. This was seen when Jorge had planned to use the software MicroWorld. There was a technical problem with the students' laptops and they could not download the software. Jorge was quick to respond and said, "okay we are not going to use MicroWorld… but I want you do to this instead…."

The teacher is also no longer the focus of attention as the dispenser of information, but rather plays the role of facilitator. As facilitator, the teacher shares their, expertise and responsibilities with students. For eample, Jorge could have

easily shown the students how to do programming, but he chose to have a student prepare a presentation and take his place.

As facilitators, teachers also need to introduce project goals and provide guidelines and resources, and move from student to student or group to group, providing support. They watch, listen, and ask questions to students in order to learn about them and about how they learn (Bracewell, et al. in press). As students work on their technology-supported activities, the teacher rotates around the room, looking over shoulders, encouraging the students to think about what they are doing and how to do it by asking questions. Therefore, a teacher needs to develop the skills of delivering and receiving information from students and monitor and evaluate simultaneously. It is multitasking at its best.

This kind of student learning and role change requires time, a commodity that is scarce amongst teacher. When a teacher is responsible for delivering instruction to a class with 25 or more students, one can rarely afford to give everyone in the class time to make presentations or work on long extended activities. And yet, teachers are required to cover the entire curriculum provided to them by policymakers.

Using technology can change the dynamics of time in schools in order to overcome some of the problem with lack of time. By helping students work more independently, technology gives teachers more time to work one-on-one or with small groups of students. Technology in a constructivist classroom can be a tool used to break the pattern in which all communication is mediated through the teacher and amongst students. It can develop more questions and discussions from

the students as seen by other researchers (Bracewell & Lajoie, 2000). There is an interweaving of teacher's and student's discourse in the construction of the lesson's content.

Incorporating technologies such as conferencing increases the discussion and communication between teachers and students, and amongst the students themselves. Furthermore, the discourse between the students and teachers is not limited to the class period but is extended to outside classroom hours. With internet teachers and students can communicate anytime and anywhere, providing teachers with the flexibility to look back at the work students have completed that day and provide immediate feedback. This means teachers do not to have to wait for test time to evaluate students, and students can still gain the individualized attention and support. Another positive contribution the internet can have in constructivist learning environment is that students with computers at home can continue to work on their projects in much the same way as they would in class, which can extend their learning. And extending their learning outside of class is the fundamental idea of building lifelong learners. To be able to use the skills acquired in class outside of the school environment.

Constructivist teaching practices supported by technology can also encourage students to handle more complex task and higher-order skills such as programming. Thoughtful work on projects and problems requires students to roam through complex resources, seeking inspiration, messing around, making mistakes, and experiencing serendipitous discoveries. The teacher's role in facilitating problem solving activities, giving more power to the students, and having control

and actively involved in their own learning is a vital reality in a constructivist classroom. The role of technology in a constructivist classroom is to provide students with tools and information that supports their problem solving, communication, collaboration, and knowledge creation. This was clearly seen in this study with the students sharing their written programs and suggestions with other students on the conference.

Constructivist teaching practices also increases students' interest in learning and participating in the hands on activities. Jorge's students were eager to come to class get their robot and quickly make modifications to their program and test it. Jorge, reinforced the students' interest when he captured their prior knowledge of playing with Lego, which was a familiar and an enjoyable experience to the students, and he built on that knowledge to construct another meaningful experience. Students were able to understand and connect what they were doing to the world outside of class and make their own interpretation of the new construct. One boy say, " I will never be a programmer... I would hate to do this type of work," another said, " I liked the part where I had to tell everyone what to do." Encouraging students to use some of the same tools as professional working people, students learn what it would be like to work in a particular career field, such as programmer, builder, or management without leaving their classrooms. Experiences like these help to prepare young people for a rapidly changing, highly technological world.

Assigning technology-based projects to small groups of students also creates a considerable amount of tutoring around the use of technology itself, and it

fosters students to work cooperatively. This was seen with Jorge's students, as one team completes their task they would walk over to another group and ask others how they were doing and providing suggestion to help the other team out.

> Student 1:"Try changing the wheels on your vehicle, they [the wheels] are too small and can not go over the ramp…"

Students were also very supportive of other teams successes and triumphs. When one of the teams was struggling with their program at task 4 and finally got the program to work, many of the classmates gathered around the platform hill to see how the robot performed. When it successfully climbed up and came back down everyone cheered. They also asked questions to the team on what they did to make it work

> Student 2: "Hey Paul, [another boy from another team] which program did you use."

The student-centered approach is clearly apparent in Jorge's class. As he relinquished his teaching power the students assumed more control of their learning which helped them to learn how to make their own decisions. Clearly the focus was not on teaching but on the students' process of learning but with the intention that, as future adults, they will have developed the skills to learn and solve problems independently.

As mentioned earlier, the teachers, in this study, are responsible for their own knowledge building of ICT in curriculums. But when they do have the opportunity to work together with other teachers it increases their motivation to learn new technologies and attempt to adopt them in their practices. To encourage teachers to work together administrators or school boards need to acknowledge their efforts. But more importantly, provide them with the time and resources to work on joint projects.

A well-developed curriculum would guide teachers on how and when technology should be used with students. Sahl and Windschitl (2000, p. 5) stated it perfectly, "Even if teachers are proficient many lack the understanding of how the various tools of technology can be incorporated into their existing classroom structure, and perhaps most importantly, a few are able to envision how technology can facilitate new and more sophisticated learning activities".

Chapter VII

RESEARCH CONTRIBUTION

Implications

This study is a view on the teaching practices that are occurring in schools. Many studies on constructivist teaching practices and ICT in classrooms have reported challenges and benefits. The motivation for this study was to contribute to the understanding of the instructional activities that teachers in Quebec are adopting to meet the new educational requirements. The last time the government of Quebec

made major changes in the education reform was in the 60's and that means many teachers were only familiar with the traditional teacher-centered way of teaching. For that reason it is important to evaluate the implications of the new reform. It is essential to understand what the growing pains are and what can be done to guide the teachers in this new way approach.

The government cannot take it for granted that the reform has been sealed and delivered to all school administrators, and all is well and adequate effective teaching is occurring in classrooms. As Windschitl and Kurt (2002) claimed, having computers in the classroom does not necessarily transform teaching practices.

This study has identified benefits of ICT in education, however, the challenges outnumbered the benefits. Policy makers cannot ignore these challenges if they want the quality of education to maintain high standard.

Limitations

The interviews with the teachers were conducted over a period of eight months (October to May) but the classroom observations were conducted over a two-month period (April and May) producing a snapshot of a classroom activity during that particular period. It is possible that the make-up of classroom activities may differ depending on the period of the year. As well, the make-up of the classroom may change over time in response to administrative and political changes in the province.

Another limitation is the small sample used to analyze the teaching practices. The results cannot be generalized to other educational settings. Particularly in this case, the subject is teaching in a private school setting and it is not reflective of the majority of the schools in the province of Quebec. However, it may provide a snapshot if an "ideal" best-case scenario, demonstrating that even in the best case, challenges occur.

Future Research

In many jobs today, people use technology for communication, information gathering, and problem solving. Therefore, more research should be conducted in finding ways that ICT can be used in education to better prepare the students for the future. This exploratory study revealed many interesting themes that could be explored in greater depth in future studies. For instance, one could explore how interactive technology can offer richer materials for learning, and support learning. Instead of asking, "what are the teaching practices in a constructivist classroom supported by technology," future studies need to focus on a more social and cognitive questions such as "How can technologies used by teachers in education help students learn and prepare for the world outside of school?"

Findings from this research point out that considerably more research needs to be done in the areas of professional development, curriculum reform, and guidelines to aid teachers in changing their teaching practices and ICT in classrooms. Research in these areas would guide policymakers in preparing

strategies on how to use technologies to achieve educational goals and influence students' knowledge.

Chapter VIII

Conclusion

Today students are immersed in technology. They surf the net, chat for hours with several friends on email, download music and movies, and play video games on computers. And in the world of work, ICT has shaped the way people communicate, take in, distribute and analyze information. The government of Quebec has recognized how ICT has changed our culture; therefore, as part of their reform vision they have made it compulsory for all elementary and secondary teachers to use ICT in their classrooms. However, integrating ICT in a constructivist classroom implies more than just an introductory of a new legislated document on the part of policy makers.

The two schools in this study have incorporated computers in their classrooms, but the results have shown that, although teachers have seen the benefits with ICT, their efforts to embrace it are hindered by challenges. As a result, current ICT usage by teachers and students can be trivial. The challenges include a pressing need for supportive professional development, technical problems, lack of time for teachers to learn, plan and share knowledge with other teachers, lack of accessibility to equipment, and on going struggle with classroom management.

The MEQ's pedagogical guidelines are general frameworks, but it is the teachers who have to create an educational environment that encourages students to play an active role in their learning, to make them aware of their resources and encourage them to use these resources, and finally, to motivate them to transfer their learnings from school to everyday life (Ministère de l'Éducation, 2002). These guidelines do not provide teachers with clear and practical direction. They can be open to different interpretations. Ultimately, the responsibility lies with the teachers to acquire and learn new technologies and incorporate them into their new learning environment. The MEQ and pedagogical administrators have failed to provide further support to teachers in adopting ICT in the wave of a new reform. What teachers need are more direction, more instruction on how to use ICT, and feedback on how well they are adopting them in a constructivist classroom setting.

ICT can be powerful for educational improvement, but like books and pencils and calculators, advanced hardware and software are most useful when used for clearly defined purposes. Therefore, administrators and policymakers need to think of ways to make it easier for teachers to adopt ICT in the classrooms so it becomes second nature to them and not a burden. Until policy makers begin to address this, the result will be that constructivist progress in education supported by ICT will remain a slow and lengthy process.

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Appendix A1
Ethical Conduct for Research Involving Humans Form

Appendix A2

Teacher / Administrator / Board Member
AGREEMENT TO PARTICIPATE IN RESEARCH

Greetings, and let us introduce ourselves and advise you of the reason we have contacted you.

Robert Bracewell is a professor in the Faculty of Education at McGill University, and Carmen Sicilia is an educator and graduate student in the Faculty. Over the next year, we will be conducting a project at Selwyn House School that examines how to use computers effectively in class and labs to promote student learning. We are interested both in the planning of instructional activities using computers and in their actual implementation and use in classrooms, libraries, and computer labs. From time to time over the next year, we will be videotaping teachers and students as they carry out classroom activities using computers. We will also videotape planning meetings of your information technology committee. Finally, we will be interviewing teachers, students, administrators, and involved Board Members on audio tape in order to get their views of how to use computers effectively to do school tasks and to support learning. The results of the study will be used to inform the future development of computer-based instruction in classrooms and laboratories.

For the purpose of analysis all names will be removed from the data. All data from this study will be kept confidential and will be used strictly for research and instructional purposes. Student participation will in no way affect grading and assessment. Both student and parent consent will be required for student participation. All those involved are free to refuse to participate in the study without fear of any negative consequences and are free to withdraw their consent and discontinue their involvement in the study at any time.

For further information, please contact Robert Bracewell at McGill University, 398-3443 (robert.bracewell@mcgill.ca).

Please fill in the form below as per your willingness to participate in this research.

I have read this consent form and understand what my participation involves. Please circle yes or no to indicate whether or not you agree:

Yes / No _____to use the data gathered for publication purposes.

Yes / No _____to use the videotaped material gathered for publication purposes and scholarly dissemination

Yes / No _____to use the transcribed audio data gathered for publication purposes.

_____ _____

Signature Date

_____

Please Print Name

Appendix A3

High School Student and Parent
AGREEMENT TO PARTICIPATE IN RESEARCH

Greetings and let us introduce ourselves and advise you of the reason we have contacted you.

Robert Bracewell is a professor in the Faculty of Education at McGill University, and Carmen Sicilia is an educator and graduate student in the Faculty. Over the next year we will be conducting a project at Selwyn House School that examining how to use computers effectively in class and labs to promote student learning. From time to time, we will be videotaping teachers and students as they carry out classroom activities using computers. We will also be interviewing students on audiotape in order to get their views of how to use computers effectively to do school tasks and to support learning. The results of the study will be used to inform the future development of computer-based instruction in classrooms and laboratories.

For the purpose of analysis student names will be removed for the data. All data from this study will be kept confidential and will be used strictly for research and instructional purposes. Student participation will in no way affect grading and assessment. Students are free to refuse to participate in the study without fear of any negative consequences and are free to withdraw their consent and discontinue their involvement in the study at any time.

For further information, please contact Robert Bracewell at McGill University, 398-3443 (email: robert.bracewell@mcgill.ca).

Please fill in the form below as per your willingness to participate in this research.

I have read this consent form and understand what my participation involves.
I give my consent to Prof. Robert J. Bracewell (please circle yes or no based on whether or not you agree to consent):

Yes / No to use the data gathered for publication purposes.

Yes / No to use the videotaped material gathered for publication purposes and public dissemination

Yes / No to use the transcribed audio data gathered for publication purposes.

_____ _____
Student Signature Date

_____
Print Name

_____ _____
Parent Signature Date

_____
Print Name

Appendix B1

1st Interview Questions

1. Could tell me just a little bit about what the unit project.
2. What are the objectives of the unit?
3. What are you hoping to have the students learn?
4. What role did you play in putting the unit together?
5. Did you use any technology in the classroom to teach the unit? If so how was what technology was involved?
6. When you were putting this project together, were you learning any new software or not?
7. How much time did you put into the design of the lessons?
8. Did you work on it by yourself or with other teachers?
9. How do you think the unit went?
10. How did you evaluate the students for their work?
11. Did your teaching practices change with this unit?
12. What are your thoughts about the students' learning, do you think that they learned what you set out?
13. Would you do it again?

Appendix B2

2nd Interview Questions

1. What do you know now about using computers in the classroom that you didn't know say five years ago or ten years ago?

2. How has your preparation and instructional practice changed as a result of having the computers in the school?

3. Tell us about the programs that are in place in the school. For example the laptop programs.

4. Tell how some background about yourself example how long have you been teaching, what is your position here and your responsibilities?

5. What kind of technology do you personally use in the classroom?

6. Are some of the use of the computers by the students individual or cooperative or a mix?

7. Can you tell me a little bit about how the students work in the classroom with the technology? What worked best with the students?

8. Concerning your students' learning, what are the changes in your expectancies or pedagogical goals?

9. What curriculum topics were easiest and difficult to integrate with the computers?

10. How important is it for you or the students to know about the hardware aspects of the computing system?

11. What is the communication like now in the classrooms?

12. How did you learn about the new technologies? Were there any special training courses your assisted?

13. What would you say would be your level of computer knowledge?

14. What kind of technical support does the school have?

15. Can you explain to me what challenges, if any have you experienced with the integration of computers in the classroom?

16. Would you say that your teaching practices have changed since ICT was introduced? If so how?

17. What is your opinion about ICT in curriculum?

Appendix C1

Semantic coding Model : frames for control, belief, and action content

Characteristic	Semantic structure	Example
GOALS		
Intentionality	Volitional lexical identifier (with *agent* relation in *theme* slot)	"what I want to get down here" *want*-THEME-*[I*-AGENT-*get down]*
	Agent relation: *first* (singular or plural), *second*, or *impersonal* (third person) (with action marked as future or potential)	"what you should say here is..." *you*-AGENT-*say*-MODALITY:ROOT
Future action	Action temporally marked as future (with *agent* relation)	"we're going to talk about that later on" *we* AGENT-*talk* - TENSE:FUTURE
Potential action	Action modally marked as qualified, ability, or necessary (includes *imperative mood*), (with *agent* relation)	"let me tell you ..." *(you)*-AGENT-*let* - MODALITY:ROOT
	Disjunction relation between actions (with *agent* relation)	"either I drop the show or I drop Reagan" *[drop show]*-OR-EXCLUSIVE-*[drop Reagan]*
	Goal case relation (with *agent* relation)	"What is the word I'm looking for?" *I*-AGENT-*look for*-GOAL-*word*
	Query of case relation or truth value	"how do you think we can get around this problem?" *get around*-INSTRUMENT-*how?*
	Hypothetical action (with *agent* relation)	"if I look back four periods..." *look back*-CONDITIONAL-'empty'

Characteristic	Semantic structure	Example
EVALUATIONS		
Attribute relation	Psychological attribute relation with a *goal or content*	"I'll start that now. Okay"
		[goal] -ATTRIBUTE-*okay*
		"it fits nicely there"
		it-ATTRIBUTE-'*fits nicely*'
Truth value relation	Equivalence of truth values	"'it collects from DISC-MR each type of element', 'yeah.'"
		EQUIVALENCE: *[it collects...] [yeah]*
	Qualification of truth value	"'it's defined to both of our satisfactions', 'except it's not just the System Admistrator here...'"
		ADVERS-CONDITIONAL: *[defined...] [except...]*
BELIEFS		
Cognition	Thought action (with first person *patient* relation and *theme* relation)	"I think the first year we had more technical problems"
		I-PATIENT-*think*-THEME-*[more problems]*
Observation	Perceptual action (with first person *patient* relation and *theme* relation)	"One thing I've noticed is that they've really developed a pride of authorship..."
		I-PATIENT-*notice*-THEME-*[they've developed...]*
PRACTICE	Action with first person *agent* relation	"I'm not using the computer connected to the server..."
		I-*AGENT*-use

APPENDIX C2
CLASSROOM PRACTICES

CLASSROOM ORGANIZATION (PHYSICAL LAYOUT OF CLASSROOM)			
BEFORE		**AFTER**	
In rows, the desk of the teacher is in the front or the back of the classroom		Desk are arranged in clusters or groups, the teacher's desk is not central to classroom	
		Other configuration?	

CLASSROOM MANAGEMENT			
BEFORE		**AFTER**	
The class is quiet and the children sit still at their desks. They work alone		Children move around and there is a moderate noise level tolerated. Children work alone and in groups	

PEDAGOGY (HOW IS THE MATERIAL TAUGHT)			
BEFORE		**AFTER**	
- teacher centred - Lecture is given to the whole class at once, in front of the blackboard, book in hand, the students have the book open on their desk		- student centred - Taught in small clusters, repeated several times, add the new material when appropriate in project, as well as lectures to the whole class	
		- student centred - Taught in small clusters, repeated several times, add the new material when appropriate in project	

PEDAGOGICAL TOOLS			
BEFORE		**AFTER**	
Pens, paper, video, books		Computer and software, class trips (not just to visit but as part of a learning module), experts giving lectures in the classroom or going to , access to other resources, student buddies (students from other classes come in to help)	

ORGANIZATION OF CLASSROOM TIME			
BEFORE		**AFTER**	
Rigid adherence to preset schedule		Follow a planned schedule which can be changed based on feedback of students or on pedagogical needs	

LESSON PLAN PREPARATION			
BEFORE		**AFTER**	
The same plan is followed year after year, some interesting fact or visual material might be added		Lesson plans are updated to reflect the latest research/knowledge on the subject as well as including interesting fact and visual material. Research is done using computers/computer software/the Internet	

WHO IS IN THE CLASSROOM			
BEFORE		**AFTER**	
Only the teacher was in the classroom with the occasional visit of an expert. A new visitor in the class caused quite a bit of chaos. Only one grade per classroom. There might be a special needs child in the class.		The classroom is a place when there is a lot of movement. This does not disturb class time. The classroom includes a cycle which made up of two grades. Some other students (buddies) come in at times as well as other teachers (experts, subject teachers, those helping children with special needs, or technicians). Students come from many different background and abilities, these are visible and acknowledged.	

EVALUATION			
BEFORE		**AFTER**	
- based on the achievement of certain objectives (atteinte des objectifs) - Exams based on the use of paper and pencil. The exam is the same for everyone and is written at the same time, the evaluation is most often summative with a few formative exams or tests in between. These exams or tests are graded and the students are compared to each other and the average standard. A few comments can be added to the final bulletin.		- based on evaluation of competences - Written exams are part of an overall evaluation plan which include many other methods Evaluation is done while the students are working on or have accomplished a project, a module, course or cycle. Different tools are used, paper and pencil being one of them. The methods of evaluation can be the same for everyone in the class or can differ slightly. These evaluations which are not called tests or exams are formative in nature and can be formal or informal. Students are evaluated on their progress and/or their level of achievement of the national standards. There might be grades assigned, comments written or other forms used to communicate the results.	

ENFORCEMENT OF CLASSROOM RULES/DISCIPLINE/CONFLICT RESOLUTION			
BEFORE		**AFTER**	
- teacher centred - The teachers makes and enforces the rules, disciplining takes on the forms of some discussion followed by punishment		- student centred - The rules are a mixture of teacher centered (teacher makes the rules) and rules the students have decided upon. There is discussion when there are disciplinary problems, either with the individual, the whole class or between the students who have the conflict. The teacher acts as a facilitator to help towards the resolution. The students as well as the teacher enforce the rules. Different methods of punishment/time to reflect on the problem are used.	

Appendix C3

Constructivist Teaching Practices Model (Tolman & Hardy, 1995).

(1) ***Activating prior knowledge****:* refers to retrieving or pulling from a student's prior knowledge that can activated in many ways. For example, by asking students what they know, by brainstorming, by doing semantic mapping, by predicting outcomes or by performing some skill or process.

(2) ***Acquire knowledge*****:** refers to once prior knowledge is activated, students must interpret new information in the context of what they already know in order to effectively acquire new knowledge. In order to build on students' preexisting understandings of a topic, teachers must become familiar with their prior knowledge. This can be done in many ways, including simply asking students what they know, brainstorming, administering surveys, and concept mapping.

(3) ***Understanding knowledge*** involves students exploring and communicating their own interpretations of the new knowledge. Teachers must provide many ways for new knowledge to be shared. Oral reports, individual projects, group activities in which students express their ideas, demonstrations, and role-playing are all ways in which students can communicate understandings.

(4) ***Using knowledge****:* Teachers must immediately encourage students to use their new knowledge in unique situations in order to make meaningful connections to their prior understandings. The most effective activities for knowledge use are problem-solving activities. An effective way to have students use their new knowledge is have them work in groups to solve problems, it is more useful than when they work alone because they have the opportunity to constantly voice ideas and receive feedback

(5) ***Reflection:*** refers to understanding what one knows. The teacher provides activities that ask students to look back at what they have learned. Journal writing and portfolios are good technique to promote reflecting.

Appendix C4

Constructivist Teaching Practices Grid (Tolman & Hardy, 1995).

- Activating prior knowledge,
- Acquiring knowledge,
- Understanding knowledge,
- Using knowledge,
- Reflecting on knowledge

How did teacher Activate student prior knowledge:

Task - activity	ICT tools used	Prior knowledge

What teaching practices did teacher apply to have student's acquire knowledge:

Task –activity	ICT tools used	Acquire their own Knowledge

Did the teacher help the student to understand the knowledge?

Task - activity	ICT tools used	Understanding Knowledge

Did the teacher help the student to use the knowledge, if so how did he do that?

Task - activity	ICT tools used	Using knowledge

Did the teacher allow students to elect on their learning? If so how was this done?

Task - activity	ICT tools used	Reflection

Appendix D1

Student Logs

Time and Date	Work done	Jobs	Plan for next interval
Day 1			
12:15 April 13, 2005	Unpacking	Francis: Project manager unpacked Jamie: Builder unpacked Robbie: Programmer unpacked	Put green boxes away
8:49 April 14, 2005	Finished unpacking Finished putting in batteries	Francis: Programmer Build robot Jamie: Project manager Build robot Robbie : Builder Build robot	Build robot to roll on flat surface, and finish structure of robot.
Day 2			
9:25 April 14, 2005	Finished structure of robot	Francis: Programmer Finish structure Jamie: Project manager Finish structure Robbie : Builder Finish structure	Clean up
9:32 April 14, 2005	Clean up	Francis: Programmer Clean up Jamie: Project manager Clean up Robbie : Builder Clean up	Test robot speed per second
Day 3			
1:50 April 19, 2005	Take green box	Francis: Builder Jamie: Programmer Took green boxes Robbie: Project manager	Test speed per second
2:20 April 19, 2005	Re-built robot	Francis: Builder Re-build robot Jamie: Programmer Start to program robot Robbie: Project manager Attended: project manager meeting	Program robot
2:30 April 19, 2005	Programmed Robot	Francis: Builder Program robot Jamie: Programmer Program robot Robbie: Project manager	Test speed per second

		Program robot	
Day 4			
9:46 April 21, 2005	Take boxes from shelf	Francis: Project manager Jamie: Builder Robbie: Programmer	Test speed per second
10:28 April 21, 2005	Test speed per second	Francis: Project manager Attended project manager meeting Jamie: Builder Edit robot Robbie: Programmer	Make robot go, turn around and come back
10:55 April 21, 2005	Start to make the robot turn around	Francis: Project manager Helped program robot Jamie: Builder Helped program robot Robbie: Programmer Helped program robot	Make the robot turn around
Day 5			
9:59 April 22, 2005	Install USB tower	Francis: Everything Installed USB tower	Making robot turn around
11:02 April 22, 2005	Started to make robot turn	Francis: Everything Program robot	Clean up
Day 6			
1:35 April 26, 2005	Take green box	Francis: Programmer Jamie: Projects manager Robbie: Builder	Make robot go up ramp
2:35 April 26, 2005	Make robot turn around	Francis: Programmer Program Jamie: Projects manager Program Robbie: Builder Program	Make robot turn on ramp
Day 7			
11:13 April 27, 2005	Put resting pad on	Francis: Builder Jamie: Programmer Robbie: Project manager	Make robot turn on ramp
12:15 April 27, 2005	Make robot turn on platform. Make robot stop and black line and come back.	Francis: Builder Program robot Jamie: Programmer Program Robbie: Project manager Build and attend meeting	Micro worlds

Day 8			
8:43 April 28, 2005	Make robot turn around. Almost done the light sensor task	Francis: Project manager Jamie Builder Robbie: Programmer	Make robot go no 4 tiles and do something different every tile
8:55 April 28, 2005	Made robot stop and black line and come back	Francis: Project manager Jamie Builder Robbie: Programmer	Make robot go no 4 tiles and do something different every