OECD/CERI ICT PROGRAMME

A Case Study of ICT and School Improvement at Crocodile Valley Secondary School (1) British Columbia Canada

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Executive Summary

Introduction

A case study for the OECD qualitative research project *Case Studies of Organisational Change* was carried out February 15-28, 2001 at Crocodile Valley Secondary School[1] in the Lower Mainland in British Columbia. The study was one of several case studies conducted across Canada in late 2000 and early 2001 that would later contribute to the OECD international research project. The research protocol was developed by

OECD and was standardized across research sites.

The data collection was carried out by means of:

- interviews with key personnel (students, parents, teachers, administrators)
- observations of lessons
- analysis of school documents, including student work samples
- survey of teacher ICT practices
- search for related news articles and journal articles

The research focused on a major reform in the school and the part that ICT has played in that reform. In the case of this school, initially the major reform identified (by district administrators) was for the school to draw in increased numbers of students in the attendance area by placing a new emphasis on ICT and was initiated in the mid-1980s. At the time of the reform, students could choose to enroll in a secondary school in their attendance area or in neighbouring communities; enrollment was declining and several secondary schools in the district had closed prior to the reform. Two catalysts to the reform were the availability of new money within the province specifically for enhancing technology use in schools, and an interest by the staff to use new technology tools for instruction. In effect, the availability of new money coupled with the district and school administration's support of ICT use in the school brought about substantial changes in how teachers worked together and planned for instruction.

The innovative use of ICT in the school ebbed and flowed through the mid-1980s to the present. This report provides a unique glimpse at how various factors within the school and throughout the district at times contributed to new uses of ICT and at other times detracted from innovative practices at Crocodile. Further, with the success of ICT at Crocodile, the district administration embarked on a plan to introduce ICT across all secondary schools in the district with Crocodile serving as the model of the best practices.

Overview

The first thing one notices upon approaching Crocodile Valley Secondary School are three large satellite dishes on top of the school roofs. No longer in use, the satellite dishes serve as a reminder to longtime faculty that their school once held the position of leader of technology in the district. Now, like the plaques adorning the walls celebrating past technology achievements, the emphasis on technology in the school is a distant, if not forgotten memory. But Crocodile, with a relatively long history of over 15 years of technology integration, provides a unique view of how various influences such as teacher interest and initiative, access to district and provincial resources, and district mandates mediate ICT use.

Figure 1. One of three satellite dishes still visible at Crocodile

Many of what were considered innovative practices in the 80s and 90s have become common practices in the school and have also strongly influenced ICT implementation throughout the district. There is a taken-for-granted nature about technology use at Crocodile now and the current principal struggles with how to initiate a resurgence of interest in teacher collaboration and learning using technology resources.

School and District Background

Crocodile Valley Secondary School is located in the Lower Mainland in British Columbia in a large urban area. In the late-1980s, Crocodile began developing a reputation as a school leading the way in technology. It was the first school in Canada to have a satellite receiving system and one of the first to offer students the capacity to communicate with students in other countries via computer. Providing a bit of historical perspective, the then principal described Crocodile as

> *One of six secondary schools in the district . . . situated in a residential area adjacent to two neighboring school districts and serves a diverse population, in terms of need, ability, and multi-ethnicity of 1200 students in grades 8 through 12. . . when the technology program was being planned for implementation at Crocodile Valley, the total enrolment was approximately 700 students. There was no technology at the school nor were there any "technocrats" on staff.*

Today, there are about 1050 students at Crocodile. The most recent district survey (1998) reports that 70 languages other than English are spoken in the home and that for 33.8% of students, English is their second language. In the mid-1980s, Crocodile

was the only school receiving significant resource monies for technology from the district and province; this was supplemented by curricular awards and grants secured by faculty teams. Today, the resources are spread equitably across district schools and parents play an important role in computer acquisition.

The Past

Setting the Stage

In the 1970s and early 80s, a handful of teachers in the Lower Mainland began investigating new technologies for teaching. The teachers interviewed at Crocodile consistently expressed that they were interested in trying new teaching methods to enhance instruction, and as technologies became available, some teachers naturally experimented with technology tools as they would any new method or idea. They emphasized the use of technology as a new means to an end. As an English teacher explained, technology is

- *Only a conduit through which my own creativity, my teaching, my students pass on their way to knowledge, but they [technologies] are not the end result*. The point was echoed by a colleague, *technology is only one of the tools I use. It's an exciting tool, but it's not the only tool.*

One former teacher recalled this example:

- *I have done a lot of work since the early 80s with my kids . . . . street kids, either on their way to jail or just out. We did things with bitnet and things like that before the Internet. I had kids linked up with Israel and Japan and all sorts of places . . . . I started seeing the potential of these kids that were really turned off, and I found that I could really motivate them and get them to do things like writing properly.*

The early interest in technology by these teachers set the stage for how quickly technology would be accepted and implemented by other teachers at Crocodile in the years to follow. In fact, teacher interest, administrator support, and new monies for technology all served to change how teachers worked together and planned for instruction. The impetus for this change came from the district's concern about decreasing enrollment and its subsequent naming of Crocodile Valley as a new center for technology in the district.

Declining Enrollment: A District Concern That Leads to Reform

In the mid-1980s, district administrators were becoming concerned about declining enrollment. At one point, the district had 13 secondary schools but by the early 1980s, seven had closed due to lack of enrollment. As new communities developed and new schools were built, families began to move out to the suburbs. Additionally, many students who had remained in the district elected in increasing numbers to attend schools outside of their home district. To address the problem of declining enrollment, district administrators decided to develop a theme for each remaining secondary school in order to keep students and attract others from nearby communities. One district administrator remembers that,

- *We were losing students . . . . So there was a deliberate effort at that time to try to create an identity around each of the different schools. Crocodile became the technology school . . . . We actually moved Jackie [who became the technology coordinator] to Crocodile because in those days he was one of the few people . . . that really had passions about technology.*

The district also hired a new principal Jean-Louis Bournot for Crocodile, who was not an expert in technology, but was very interested in promoting the use of technology and encouraging of faculty who were also interested. Many faculty credit Bournot's support as the key to why they were able to so easily begin to use technology in their classroom. Bournot gave teachers the "go ahead" to try out their ideas. A case study conducted on Crocodile in 1990 also credited Bournot's leadership,

- *It is evident that the specific selection of the school's principal and technology coordinator to launch the effort has been a critical element in the successes that have been achieved. [They] are credited with being "problem solvers" who work very effectively as a team in supporting teachers in need of assistance. Their style has been to encourage the voluntary participation of their colleagues by example, rather than to press for involvement, with its higher risk of rejection*.

Catalyst I: Funds for Technology

Just before Bournot's arrival, several teachers had already put forth a successful grant for new computer equipment. Bournot immediately encouraged these teachers to develop additional grants and to connect with other teachers in the school in collaborative projects centered on technology. An example of this was participation by several teachers in the Writers in Electronic Residence program in Toronto. Then in 1987, the school applied for money from the *Funds For Excellence*, a new Ministry program with funds specifically earmarked for technology. Each Subject Area Head presented consensus plans for how ICT could be incorporated in their subject areas or across subject areas. Working across subject areas was referred to by Bournot as the Broad Implementation Model. A review of early technology efforts at Crocodile reported that,

- *The decision was taken to apply a variety of information technologies on a broad basis, rather than to focus on one or two specific applications [or subject areas]. This appears to have provided a framework for participation by many teachers who had previously been neutral, if not negative, toward the intrusion of technology into their professional lives.*

The *Funds For Excellence* brought an infusion of funds to Crocodile, which resulted in the development of two computer labs. To save money, the principal, technology coordinator and a custodian then came in at nights and evenings to wire every classroom with cables and television monitors. Further money saving efforts included numerous collaborations with companies such as IBM and AT&T. Early in 1988, Phase II of the Broad Implementation Plan began with the placement of satellite dishes on the roofs of the school&endash;the first school in Canada to have a satellite receiving system.

Catalyst II: Teacher Interest

The Broad Implementation Plan brought about numerous changes for teachers in the way they viewed the teaching and learning process and their instructional methods. The commitment to technology required significant personal commitment and time. Building on early successes, early adopters began planning projects with other teachers to utilize the new technology resources. Several teachers also applied for more funding and submitted their technology-enhanced curricular projects to competitions, which often also brought more funding for computers and other technology. As one teacher explained, "*the culture of the school very much supported experimenting with new ideas*."

Projects initiated during this time included transmission between the school and NASA. This project enabled students to communicate with astronauts through satellite receivers and two-way audio connections. Worldwide news and educational programming was regularly broadcast into the classroom and there was wide participation in a distance learning and writing project with students in other countries sponsored by AT&T.

A major project initiated in late 1988 by a language arts teacher brought students at Crocodile together with Olympic athletes in Korea. Developed as a writing project entitled *Windows on the World*, students developed and practiced their writing skills by using the Internet to write to the Olympic athletes. They also watched the athletes compete in their Olympic events on the classroom monitors. Recalling the experience, Patricia, the English teacher relates,

- *Everyday my students would come and watch the CBC [national news station]. We couldn't watch them all live . . . so I would tape them and bring them in. Pretty soon the kids were sending messages to the athletes and the athletes were sending messages back. Now that hadn't ever been done before. What was really neat was when the Olympics were over, there was still contact going on between the students and the people they had written to.*

This curricular project was one of several in the school that won national and international recognition during the late 1980s and early 90s. It also spurred the development of collaborative and cross-curricular planning on how to use the new technology resources in the school.

Although language arts classes were heavy users of the various technologies at Crocodile, other curricular areas were not left out. Drama students at Crocodile worked with students in California on play development and analysis using computers to communicate ideas and investigate issues of racism. Home economics students at Crocodile participated in a series of events focussing on gender issues with another school in which students were able to view presentations and participate in discussions with one another via satellite transmissions and speaker telephones. Industrial arts classes were also restructuring both their equipment set-up and instructional planning to take advantage of new technologies&endash;particularly to try to use technologies that students might encounter in industry. A social studies teacher

who traveled to Namibia sent lessons back via the Internet and used the satellite system to broadcast lessons.

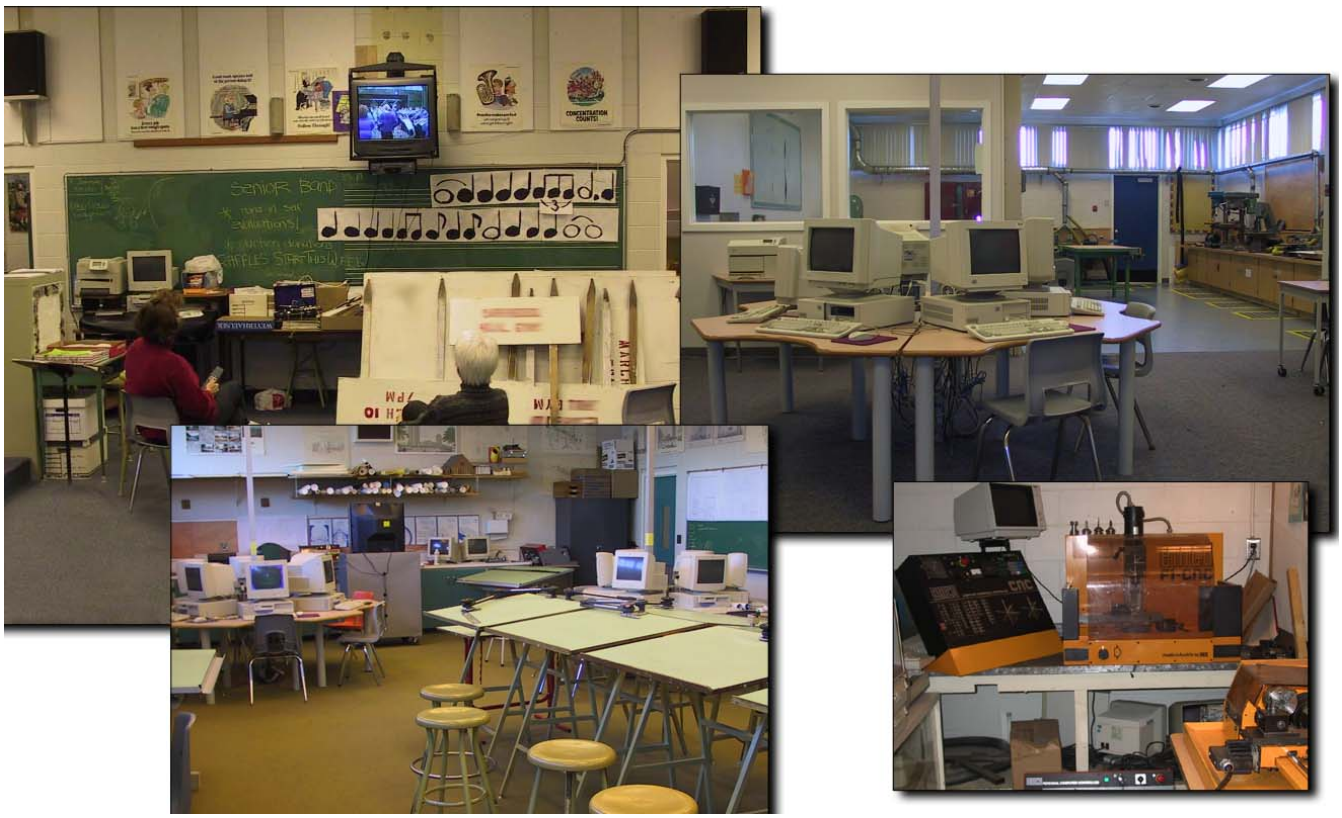

Figure 2. Technology integrated across subject areas and within the classroom setting

These examples represent how faculty from specific subject areas worked together, often with faculty from other schools, to plan cooperative instructional units. Technology enabled the teachers to work together as well as enabling students to share ideas with other students studying similar topics. The benefit of this was to broaden the perspectives presented to students and to encourage discussion on a wider variety of topics and viewpoints.

Additionally, several classrooms at Crocodile were equipped with cameras for broadcasting to a local university. In this project, teacher education students at the local university were able to watch live secondary classes. These classes were broadcast to the university in teaching methods courses and often included conversations between the university students and the classroom teachers to discuss instructional methods and curricular decisions.

- *Each of these projects involved a team of teachers . . . collaboratively designing curriculum units. As a teacher involved in this project, I found the experience both rewarding and challenging. At times the project was frustrating due to problems with the functioning of the technology equipment, however, this only forced me to examine the teaching strategies involved.*

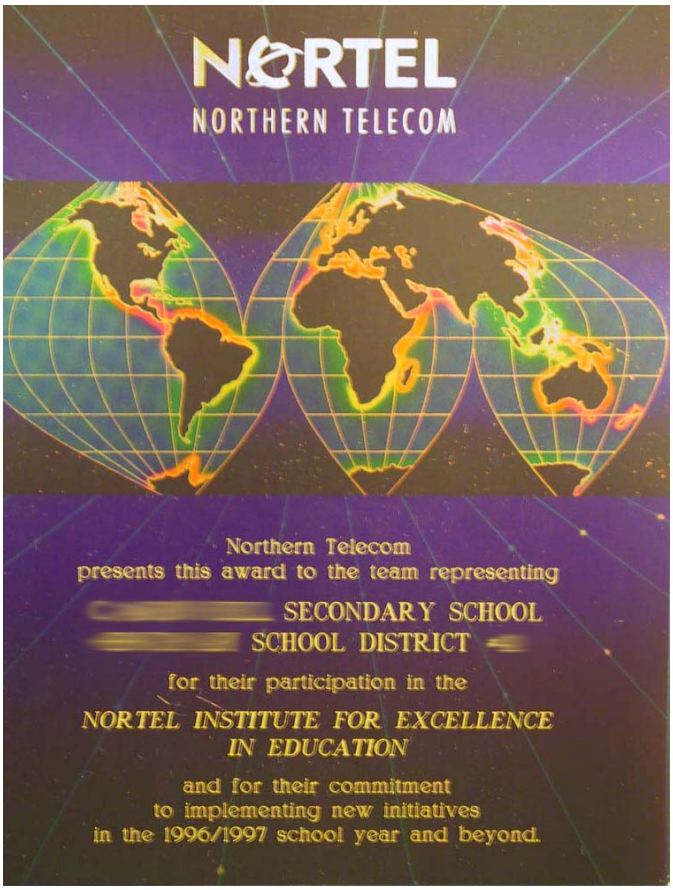

Figure 3. One of many awards for technology enhanced curricular projects. On display in the main administrative offices at Crocodile.

Lynne's paperIn many of the projects described above, teachers reiterated that the importance of achieving specific curricular goals was the first concern&endash;emphasizing again that technology was used as a tool rather than for the novelty of using something new. If the technology didn't help the students learn, it was abandoned in favor of a more successful instructional method. As the vice principal at the time commented,

- *Our focus is on using the computer as a tool for learning, rather than teaching computer science. The focus is also on teaching students that the computer, despite the mystique of complexity, is simply a new tool to make work easier and more efficient. We talked about this in our [teacher planning meeting] . . . and we set a goal that students would come in and look at a computer no differently than they would look at a book or pencil and paper in terms of its usefulness and why it's there.*

Despite the strong focus on using the computers as tools, some teachers also expressed an interest in creating opportunities for students to become knowledgeable about computers. At first, this interest was expressed in the context of learning technology skills within a subject domain or was limited to skills such as keyboarding and word processing. As more computer labs were created in the school, courses such as information technology, business education, and computer science did become quite popular with students.

How Teachers Acquired Technology Skills

Much of the teachers' early learning occurred in workshops led by other teachers in the school. In the late 80s as technology was being introduced in the school, more than half of the teachers in the school took advantage of teacher-led workshops. The 1990 study of technology use at Crocodile found that 72% of teachers felt that support and encouragement from their colleagues contributed most to their understanding and use of technology, and 65% felt that accessibility of hardware and software also contributed to their comfort level. Many teachers applied for the low-interest loans available at the time to purchase computers for their own use and gradually developed skills at home that they then could put to use in their classroom. Some teachers took advantage of evening courses in the community and still others relied more on the expertise of Jackie, the technology coordinator. Teachers presented curricular goals and ideas to Jackie and he helped to implement the ideas through the use of technology. At the time, Jackie reported that,

- *Initially, some teachers were keen, others were resistant and a few were downright hostile to the idea, but when they learned that they didn't necessarily need to be experts themselves, they were more open to it.*

In 1993, Jackie left Crocodile to become the technology coordinator at a new school in the district. By this time, many teachers had become confident in their ICT skills, while others chose to teach much as they always had&endash;without much technology. Technology was prevalent in the classroom even when teachers didn't actively use it themselves. As students began to come in to the secondary level with more advanced technology skills, the students were more apt to initiate use of ICT tools in the classrooms for presentations and reports (primarily Powerpoint and the Internet) than was previously the case.

The technology coordinators who followed Jackie took advantage of students' skills and enrolled the more advanced students in advanced Instructional Technology (IT) courses. Students in these courses were typically paired up with teachers who had expressed an interest in support. In this way, the technology coordinator was able to offer more support throughout the school and students were able to learn advanced technology skills by solving real-life problems. This type of learning was referred to as *service learning* and was popularized in the district and surrounding areas in the mid-1990s (Willinsky, 1998; Wolfson & Willinsky, 1998). This was a significant shift in how teachers learned to use and feel comfortable with technology in their classroom. As the 90s came to an end, less technology competent teachers were relying more on the skills of students than on the technology coordinator or other teachers.

Resource Availability: Open Hours and Increasing Resources

Prior to 1987, the school was limited to a few computers in special education and one in math. Lynne's paper. By the end of September 1987, three labs had been installed&endash;one for business education and two general purpose labs for all subject areas (teachers booked the lab when needed). By 1991, the school had 120 networked computers, two satellite dishes, three receivers, and monitors in every

classroom and the hallways. ARO 151. From the beginning, computer labs were open before and after school as well as during lunch. Much of the time, the labs were self-monitored or supervised by students. "*We never had any discipline problems in the lab,"* the technology coordinator explained, "*students were tougher on each other than the adults were."*

Over time, groups of three or more computers (frequently mounted on carts for ease of transporting) were acquired throughout the school so that subject areas could also benefit from computer and subject-specific applications for individual classrooms. As an example, the technology education areas (woodworking, electronics, drafting, etc) acquired 12 computers and expensive software including AutoCAD, video editing equipment, and 3D imaging software. The administrative areas also acquired computers for tracking attendance, library cataloguing and book checkout, and posting messages for hallway monitors throughout the school.

As with many early investors in technology, Crocodile soon learned that new technology does not remain new for very long. By 1993, the computers were beginning to show their age and district funds were channeled into a new school, Ace Slope Secondary that was to be even more technologically advanced than Crocodile. When Jackie left to become technology coordinator at Ace Slope, a series of technology coordinators were hired at Crocodile and then subsequently transferred throughout the district. This helped the district to spread technology use more evenly across all secondary schools, but left Crocodile with an uneven experience, as ICT procedures were changed to accommodate the style of each successive coordinator.

Whereas all of the technology coordinators at Crocodile made efforts to keep the technology up-to-date, new policies for the labs resulted in fewer open hours and the support available to teachers diminished. Not only did equipment updates and new networking schemes take precedence for the technology coordinator, but as the skilled teachers were transferred to other district schools, the new teachers who came in often were not as ICT competent. As noted previously, advanced IT students began to fill the void. Students helped to repair and re-purpose equipment, assisted teachers and other students in setting up classroom equipment, and worked with teachers individually to help develop webpages and other electronic resources.

By the late 1990s, with the help of students' rebuilding and maintenance work and with support from the parents' fund raising efforts, Crocodile had over 200 functioning computers&endash;mostly Pentium 100&emdash;466 models, with one lab of 486s available for word processing and internet use. Today these computers are spread out across 2 business education labs, 2 technology education labs (drafting and introductory technology ed.), 1 general education lab (available to all teachers for booking), the library, school administration and teacher work areas, and 3-4 computers on carts for each subject area. In addition, the school has numerous digital cameras, scanners, printers, zip drives, graphing calculators, and other peripherals.

The Present

A group of students are seated comfortably around some tables in the library. They're

in their social studies class working independently on a worksheet distributed by their teacher. Many of them are listening to CD's on their compact disc player; most having made their CD's at home by downloading songs from the Internet. Another group, from the same class, is researching topics using the internet-connected computers. The teacher wanders around offering individual help when needed. In another part of the building, students in a drafting course are working independently on a project of their choice&endash;some use AutoCAD 12 or 14, some draft by hand. Others are busy looking for a driver (using an Internet search) so that they can match up the more current AutoCAD 14 with an older output device. *"Trouble-shooting and problem-solving skills are just as important as drafting skills for these students,"* explains the instructor. And across the building, art students are comparing prints from a digital camera vs. a 35mm camera using a variety of settings.

Students comfortably use technology throughout the school and most don't give it a second thought. *"They put on a pager and carry cell phones and disc players as automatically as putting on their shoes in the morning&endash;though the pagers and phones must be kept turned off while classes are in session,"* the principal explains. Even students without a computer at home find ways to get onto the Internet. *"I use my uncle's computer." "I can go over to a friend's house and he lets me burn CD's." "My friends, we all get together and play on it at his house."* Most of the use they are referring to is not school-related. When asked about using computers for classes, the students explained that they use the lab at school and if they need equipment, like the in-focus projector for a presentation, the technology coordinator helps them set it up.

Current teacher use does not seem to mirror the ease at which students integrate technology into their daily lives. Many of the current teachers at Crocodile reported that they cannot keep up with the students, so they either don't use technology or rely on the students' expertise to bring it into the classroom. Many teachers also reported that they do not use a computer at home or if they have a computer, find it difficult to commit time to using it. In walking down the hallway, it's clear that many teachers use scrolling overhead projectors or no technology at all. Though

Figure 4. A typical look into a classroom today: A scrolling overhead projector

there are clearly a number of teachers who do use technology in the classroom, not even half of the staff report regular use. This is a dramatic change from over 75% of teachers reporting regular technology use during the late 80s to mid-90s. What accounts for this change?

As the current principal reports, there have been large staff turnovers in recent years,

- *We lost 36 staff last year and we lost 27 staff this year. This is not the same staff, there are very few people left here that were here in the hey-day. This does affect what happens in a school, the district is very aware of that.*

The principal went on to explain that staff movement to other schools positively impacted the level of technology across the district, but this has led to a decreased emphasis on technology at Crocodile. Where Crocodile was once the leader, it became the model for other secondary schools. As a district administrator explained,

- *The district deliberately experimented with technology at Crocodile and then transferred the best ideas to all of the schools. To accomplish this, it was necessary to move staff as well. In a sense, they [the other secondary schools] have been playing catch-up.*

How Teachers Explain the Change

Many teachers explained that when the technology coordinator position changed from a support person for the teachers to a general maintenance person, there was no one available to help them keep up with the changing technology. The current technology

coordinator acknowledged this situation. A lot of his time is spent fixing machines or installing software&endash;as an example, in the academic year 2000-01, the school spent $30,000 on new software. This created extra work to update and/or delete illegal software. Hardware is another issue. The advanced students spend a lot of time tearing apart old machines and taking the pieces to add to the newer machines, as little money is available for the purchase of new computers (though monies are being spent on updating infrastructure). The current technology coordinator expressed,

- *My philosophy on it is do the best we can with what we have, it's not a quest for acquisition anymore, it's a quest of integration and creative use.*

It is clear that the service learning model employed in the mid-90s is still an integral component of computer maintenance and staff support, but in recent years, the support has been to the equipment rather than the teaching staff.

The District's Initiatives

The district began its support of ICT at Crocodile in an effort to increase enrollment, but due to the success in implementation, the long-term plan became implementation of ICT resources equitably across all schools&endash;to take what was learned at Crocodile and share it district-wide. When this was accomplished, the district knew that a plan needed to be developed to help all teachers learn to effectively use ICT in the classroom. With the opening of the district's Teacher Learning Centre (TLC) in 1998, there was an expectation that teachers from across the district would use the TLC and attend district-organized professional development days (Pro-D days) to upgrade their technology skills. For Crocodile, this was a move away from the teacher-initiated workshops and collaborative planning that was prevalent when they first began to implement ICT.

The TLC is a ready resource for helping all teachers learn about and integrate technology into their classrooms. Resources are set up in the TLC for teachers to learn independently or by attending scheduled workshops after school. The district also developed *The Art of Teaching with Technology,* a district in-service plan that *"allows teachers to review best practices and learn ways of incorporating the use of technology into their teaching."* district website The plan relies on lead teachers working with other teachers during Pro-D days and then carrying this learning back to the school where the teachers can share their knowledge in their local setting.

There is also a new province-wide ICT initiative that is following a similar plan. It is aimed at grades 6 through 9 and provides learning opportunities for lead teachers who then serve as mentor teachers in their school. One of the recent hires at Crocodile was selected for this role. Crocodile's current principal alluded to the fact that he consciously selects new hires with attention toward their competence in and enthusiasm for using ICT. In this way, he hopes to re-build the type of atmosphere that existed previously at Crocodile&endash;one of collaboration and teacher-led innovation.

- *We are also upgrading our equipment. We spent $300,000 in the last three years. The labs were all upgraded, the wiring all changed, literally everything*

was upgraded. We put drops in every room so they can have Internet access.

Though Crocodile, as one of the smaller schools in the district, may no longer feel like a leader in technology, the principal notes that their resources are rich for their size and that they are in a prime position for a resurgence in faculty energy directed at ICT innovation. The school prides itself as providing excellent education and may now once again turn toward new technologies to bring this excellence to a new level.

Main hypotheses

Hypothesis 1: Technology is a strong catalyst for educational innovation and improvement, especially when the World Wide Web is involved. The rival hypothesis is that where true school-wide improvement is found, technology served only as an additional resource and not as a catalyst, that the forces that drove the improvements also drove the application of technology to specific educational problems.

Evidence in support of hypothesis 1:

Technology was a strong catalyst for reform (however the WWW was not a strong factor). The district wanted to increase enrollment at Crocodile and used technology as the means to this end. Prior to the district initiative, there was very little use of technology at the school. Introducing technology did increase enrollment.

As more teachers became involved in the effort to increase ICT use and resources, technology served as a catalyst for the change in how teachers worked together. Prior to the strong investment in technology, teachers characterized their work as independent or in subject specific grouping. From the teachers' perspective, the ICT efforts created an environment for teachers to work more collaboratively and across subject areas. Further, the ability to use ICT resources to communicate with other teachers in the district and in other countries encouraged collaboration beyond what teachers were able to do previously.

As teachers experienced success with technology, obtaining additional technology resources became a focus for teachers. This also created an environment for collaboration that did not exist before. Teachers also worked collaboratively to submit their technology-enhanced curricular projects to curriculum competitions within the province and worldwide.

Teachers explained that technology within their classroom allowed them to achieve particular educational objectives that they were not able to achieve using other instructional methods. In particular, most teachers using ICT regularly in their class explained that technology resources allowed for more independent work by students. They also explained that technology allowed them to bring new and broader perspectives into the class&endash;this was accomplished through greater access to a wider variety of resources. The teachers felt that this positively affected student learning and student growth as independent thinkers and problem solvers.

As the emphasis in ICT waned in later years, teachers again characterized their work

as independent or within subject areas and only occasionally did they collaborate with colleagues in the district (and when they did, it was at district-organized professional development days).

Specific academic problems were not identified; the school was characterized by a high level of academic achievement across subject areas. In later years, as the number of students from lower SES backgrounds entered the school, there was an identified problem that these students would also have lower ICT skills. The school administrators did not indicate that an increased exposure to ICT at Crocodile would be a solution to that perceived educational problem.

Evidence in support of the rival hypothesis:

The principal of the school (when ICT was introduced) was thought by some teachers to be the impetus for change in the school. According to some teachers, the principal encouraged teachers to work together and to try out new ideas. His enthusiasm toward developing a collaborative working environment was not limited to teachers using ICT, but was aimed at developing an excellent learning environment at the school.

Some teachers expressed that ICT interest grew in the school as a result of the emphasis placed on ICT by the district superintendent, the school principal and by the school technology coordinator, and that without this support, there would not have been much growth in the use of ICT.

2. Hypothesis: The diffusion of innovation/ improvement (and therefore of ICT) followed the traditional diffusion patterns for innovations, as outlined by Rogers (1995). The rival hypothesis is that technology functions differently from traditional innovations and that therefore different diffusion patterns occur.

Evidence in support of hypothesis 2:

There are conflicting opinions on how ICT implementation occurred at Crocodile. One opinion is that the district decided that Crocodile would be a magnet school for technology and this served as a mandate. Another opinion is that the district specifically created an environment for ICT implementation and adoption and that it was not necessarily a mandate. The district superintendent was a very strong advocate for ICT use and was credited by some as spearheading the drive to increase ICT at Crocodile. A specific principal was hired due to his favourable opinion about ICT and his enthusiasm to implement ICT. A specific teacher was transferred to Crocodile by the district to become the technology coordinator at Crocodile. He was hired due to his early use of technology in another school. These three people were thought to be responsible for communication and support of the innovation.

Some thought that teachers who were early adopters of ICT (prior to the new principal and technology coordinator being hired) were responsible for the communication, support and later the adoption of the innovation. Some district level administrators explain that Crocodile was the school chosen as the magnet school because of the presence of these early adopters (some do not think that was the case).

Evidence in support of the rival hypothesis:

Several factors occurred concurrently (or at relatively the same time) that contributed to the success of ICT at Crocodile: some teachers were using ICT already, the district decided that Crocodile should be a magnet school for technology, the principal and technology coordinator were hired due to their support of and experience with ICT, and significant district and provincial funding for ICT became available. All of these factors probably contributed to the success and cannot be considered to contribute to the traditional diffusion pattern.

Teachers without ICT competence participated equally in the initial adoption of ICT at the school and were not "laggards" as described by Rogers. Teachers were able to use the ICT resources due to the support from the technology coordinator. He did not feel that the teachers needed ICT training or skills to use the technology; he expected them to come up with the ideas that he could help implement. These teachers also participated in collaborative efforts without feeling out of place. Age and number of teaching years did not influence participation factors. Many early adopters were older, more experienced teachers. (However, in later years, the younger teachers were more likely to be more highly technology-oriented and skilled)

Many unique training opportunities were provided to teachers: teacher-led training, district sponsored in-services, afterschool community courses, low-cost computer purchase which encouraged at home and self-training, and one-on-one training by the technology coordinator. Teachers indicated that the level of the training was markedly different from when other curricular or instructional innovations had been introduced at the school.

Some felt that the district emphasis on technology at Crocodile was a mandate and that they had no choice but to learn to use technology.

3. Hypothesis: Successful implementation of ICT depends mostly on staff competence in the integration of ICT into instruction and learning. This hypothesis assumes that teachers mediate ICT applications when they are successful, and that ICT s academic value relates positively to teacher competence. The rival hypothesis is that it is the school technological infrastructure and student ICT competence rather than staff competence determine ICT implementation outcomes.

Evidence in support of hypothesis 3:

When ICT was introduced, more than half of the teachers at Crocodile took advantage of teacher-led workshops. The teachers leading the workshops were early adopters of ICT and volunteered their time to help other teachers. Some workshops and one-on-one training were offered by the technology coordinator.

In a study conducted in 1991, it was found that 72% of teachers felt that support and encouragement from their colleagues contributed most to their understanding and use of technology.

Teachers often came up with ideas for how to use technology to enhance learning in their classroom and the technology coordinator helped them to implement the ideas. There were few existing examples of how to integrate technology into subject areas, so teachers experimented with their own ideas.

Teachers took advantage of the rare opportunities offered by outside agencies to incorporate technology into their curriculum. Examples of this were working with NASA and with the AT&T sponsored writing program.

Teachers continually expressed using technology as a tool and emphasizing their interest in using technology to achieve specific instructional goals. If the technology was not helpful, they used alternate methods. The academic value of the tools was not dependent on teacher competence with technology (because the technology coordinator was available to make the technology work), it was dependent on whether the tool was appropriate or not.

When ICT was introduced at Crocodile, the majority of students had no technology skills or experience, so they were not in a position to contribute to ICT integration.

Evidence in support of the rival hypothesis:

According to the 1991 survey at Crocodile, 65% of teachers felt that accessibility of hardware and software contributed to their comfort level with ICT.

In later years (after 1995), student competence contributed to ICT use in the school. After several years of staff transfers, fewer teachers at Crocodile had strong ICT skills. To continue developing ICT use at the school, students initiated ICT use in the classroom, assisted teachers in learning, and contributed to maintaining existing equipment.

4. Hypothesis: Gaps in academic performance between high and low poverty students will not increase when all students have equal access to ICT. The rival hypothesis is that equal access to ICT will lead to more advantaged students increasing the performance gap with disadvantaged (high poverty) students.

No real data to support or refute the hypothesis was available despite numerous requests regarding the SES status of students. Most of the evidence was anecdotal in nature or limited to the opinions of various participants of the research. It is presented here with that caveat.

Evidence in support of hypothesis 4:

All students have equal access to the computer labs during open hours. All students are taught basic technology skills in a mandatory one-term technology course.

On the surface, the school appears to offer all students equal opportunities for computer use and enrollment in technology-oriented courses. It is luck of the draw whether students are enrolled in courses with teachers who use technology or not in academic subjects such as social studies, math, science, or language arts.

Students without computers at home have access to computers through friends or relatives and most students who were interviewed agreed that they had similar technology competence (despite access).

Several teachers and administrators were convinced that students from feeder schools from the lower SES neigbourhoods had lower or no technology skills and that this impacted their ability to be successful in all courses. (No data relevant to performance was available to review).

Evidence in support of the rival hypothesis:

In later years (after 1995), it appeared that students enrolled in advanced technology courses had far more computers and peripherals in their home than students who were not in these courses (based on formal and informal interviews of students). Students in the advanced courses were higher skilled in technology than students not in these courses, but overall academic performance comparisons were not available between these two groups.

5. Hypothesis: Successful implementation of ICT will lead to the same or higher academic standards in spite of the low quality of many ICT materials. Academic standards are a function of teacher and school expectations and not of the standards of textbooks, ICT materials, and the like. The alternative hypothesis is that ICT use will lead to a lowering of academic standards as students spend more time on marginally beneficial searches and in browsing poor quality Web and courseware content.

Evidence in support of hypothesis 5:

The school has maintained a high level of academic standards throughout its history. Administrators do not feel that ICT impacts their standards. They also did not feel that ICT materials were of low quality.

Teachers felt that students improved their level of performance as a result of ICT resources, particularly when the efforts were to be shared via satellite or the Internet. Students worked harder on presentations whenever they were to be shared with other students or teachers at distant locations.

Teachers felt that ICT resources enabled them to bring a wider variety of perspectives into the classroom and that this resulted in a higher level of academic excellence. (No data was available to support or refute this claim).

Evidence in support of the rival hypothesis:

In later years (after 1995), as the WWW became more popular, teachers expressed that it was possible for students to waste time on Internet searches. As a result of direct observation by the researchers, this often did seem to be the case, particularly when students use of the computers was unsupervised (but also during teacher-led activities).

Projection to the Future

Sustainability

In the late 1980s and early 90s, Crocodile Valley Secondary led the way in Canada in implementing ICT throughout their school. Teacher-initiated efforts coupled with administrative support and district and provincial resources created an environment for experimentation and led to Crocodile becoming the model for the other secondary schools in the district and to some extent, across Canada. Throughout the 1990s, Crocodile experienced a number of changes that impacted continued ICT implementation and use including staff turnover and the aging of its computers.

To effectively sustain ICT across the school curriculum, many adaptations to Crocodile's Broad Implementation Plan took place. As staff turnover occurred, teachers began to rely on students for ICT support in the classroom and then the district Teacher Learning Centre for additional training opportunities. The school continued to take advantage of district and provincial funding opportunities to replace aging computers, peripherals and wiring. Parent fund-raising also contributed to the upgrading of computers, as did student efforts to re-purpose and re-build older machines. Continued district support and high expectations for ICT use have also been key to the sustainability of ICT at Crocodile.

Continued sustainability for Crocodile will require the creative use of existing resources and the ability to take advantage of district and provincial ICT initiatives&endash;both for training and funding. Ace Slope has relied heavily on partnerships with business, particularly with IBM, but Crocodile has developed fewer of these types of relationships in recent years due to its smaller size. To obtain newer technologies, Crocodile may also have to look to building these types of relationships. Hiring of technology competent faculty will also need to be a continued priority, as will leadership to bring faculty together and to encourage experimentation with new technologies as they emerge.

Expanding the Model: Scalability of ICT Across the District

As a result of the success of Crocodile's early efforts, the district was able to initiate ICT use across the district. The success at which other schools implemented ICT points to the scalability of the efforts at Crocodile. In 1993, Ace Slope Secondary opened to 1500 students. It was wired with fibre optics, had television monitors in the hallways as well as classrooms, far more computers, and all teachers had their own computer to use for the development of lessons and other instructional materials. Today, Ace Slope, with 2600 students, continues to draw educators from across Canada interested in its large-scale implementation of ICT, though similar to Crocodile's early experiences, it too is experiencing a decline in operability of its computers and infrastructure.

In January 2001, an even newer and more technologically advanced school opened in the district, not too far from Crocodile. Topper Secondary also built on the early experiences from Crocodile and Ace Slope and is employing new technologies such as Thin Client computers and Citrix servers. The opening of Topper resulted in another disbursement of Crocodile faculty. But in return, Topper is now serving as a model for

how the Thin Client technology may be a viable option for Crocodile and other schools with older computers still in use. It is likely that 486s can be turned into Thin Client hosts and thus further extend the life of the computers that many of the schools already own.

Today, there are comparable ICT resources at all of the district secondary schools&endash;some have newer technologies in place, but these most often serve as a testing ground before being adopted district-wide. Some schools also appear to have more of some types of technologies than others, such as video editing equipment at one school or expanded technology education (drafting, woodwork, electronics) facilities at another school. Equitable in the district's eyes does not always mean the same technologies, but equal distribution of support, money, and expectations. Scalability of ICT has sometimes come at a cost to an individual school, as in shifting of staff, but on the whole, the district sees as its goals as providing an equitable experience with ICT for each student and an overall excellent educational environment across the district.

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(1) In order to preserve the anonymity of the school and staff, pseudonyms are used throughout.

References

Rogers, E.M. (1995). Diffusion of innovations. NY: Free Press.

Willinsky, J. (1998). Learning to do: Students develop IT projects that deliver service. Available at: http://www.blarg.net/~building/tech_willinsky.html

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APPENDIX A: Methodology

Site Selection

In British Columbia, it is most appropriate to approach individuals within the Ministry of Education Office for the Province. The Ministry originally proposed that the research be conducted in a school very well known throughout the Province for its use of technology. Due to accreditation procedures and other commitments, school officials believed that the study would be too disruptive and declined the invitation to participate. Another school in the same district was suggested as it was one of the first

in British Columbia to adopt a high level of technology integration by teachers, students, staff and administration and served as a model for the school originally proposed.

First contact with Crocodile Valley Secondary was January 18, 2001. The principal, vice principal (who also oversees technology), technology coordinator, 2 district assistant superintendents, and a principal from a feeder elementary school were present. The research project was described and all present in the meeting were very favourable and supportive. A 2-hour tour was given by the technology coordinator who highlighted all facilities throughout the school buildings; a number of teachers were also introduced to the head researcher. The length and depth of this meeting was not anticipated, so no formal recording occurred, but notes were made subsequent to the meeting and tour and serve as part of the data collection. Several documents regarding the history of the use of technology were also provided at this meeting.

Data collection

Three researchers were present unless otherwise noted. One researcher recorded written notes of the interviews, the other two researchers switched roles between recorder (all formal interviews were taped and transcribed) and interviewer. Classroom and school observations were conducted individually or in pairs. Digital photos and video were also used as data collection methods. Photos were particularly useful in capturing the breadth of work completed by students in the technology education area. Numerous documents were collected throughout the site visits.

The following itinerary provides an overview of the data collection efforts for the combined SITES/OECD study. A note about terminology: educational technology at this school refers to courses such as instructional technology, general computer courses and business education courses; the teacher who coordinates this area is called the Educational Technology Coordinator. Technology education refers to courses such as drafting, woodshop, metalwork, and electronics; the teacher coordinating this area is called the Technology Education Coordinator. In contrast to both of these, is the Technology Coordinator who is responsible for how the computers work throughout the school. The Technology Coordinator also teaches computer courses and assists faculty with computer technology needs.

Date	Event	Place	Notes
Thursday, 2/15	1st group of teachers interview	Social Studies Classroom	
	Interview with parents	Evening- Home Ec. Room	
Friday, 2/16	Interview with Vice Principal	Vice Prinicipal's Office	

	Interview with 2nd group of teachers	Science Classroom	
	Interview with Tech. Dept. Head	Business Ed. Lab	
	Interview with student journalists	Cafeteria	
Monday, 2/19	Interview with tech ed. teacher	Ed Tech Workroom/Office	
	Interview with technology coord.	Ed Tech Workroom/Office	
	Continued interview w/ teacher Out-of Classroom Observation	Social Studies classroom	The continued interview was at the request of the teacher, she felt that she could not respond to all questions fully during the group interview.
Tuesday, 2/20	Interview with 1 teacher involved with early use of tech (1980s) within the school	486 Computer Lab	This teacher was not on the original interview list but was mentioned throughout other interviews as a key contact
	Student interviews	Tech Ed classroom	

	Classroom Observations	Library (Social Studies class) and Tech Ed Class	
Wednesday, 2/21	Interview district level administrator	District Office	Only one interviewer present (head researcher)
Friday, 2/23	Interview teachers from other schools who formerly taught at Crocodile and were involved in the innovation	District Pro-D Day Brief interviews were in the Library of a district secondary school hosting the pro-d day	Spoke informally to teachers and arranged future interviews
Wednesday, 2/28	Wrap-up Day: interviewed the principal who had returned from sick leave	Principal's Office	
	Interviewed additional students	Tech Ed Classroom	
	Classroom Observation	Tech Ed classes-grade 8 class and drafting class	Both an unscheduled fire drill and an earthquake interrupted the interviews and observations.
	Collected the ICT surveys	Main Office	

	Interviewed the former technology coordinator	Administrative Offices at the current school where the tech coord. is now located	The interview with the former technology teacher was arranged at his current school and a district asst. superintendent was present. Two interviewers were present this day.

Organisation of the data collection

The vice principal (who oversees technology in a general way in the school) was given the task, by the principal, to arrange the interview schedule before the researchers arrived on campus. Thus, the vice principal selected the teachers for group interviews, arranged for specific parents to come in for interviews and suggested the classrooms for observation. Teachers involved in the interviews selected the students for interviews. The time allotments for interviews was also set by the vice principal and were generally 1.5-2 hours in length with the exception of the students interviews which were 1- 1.5 hours. Throughout, it was desirable to have a range of technology users and non-users in the interview sessions&endash;this was the case throughout the interviews.

To provide a more comprehensive picture of how technology was used in the school, it was clear that classroom observations and interviews beyond that which the principal arranged, would be necessary. These additional interviews were set up by the researchers with the help of the vice principal. Additional students were also selected and interviewed. These interviews and observations were conducted during the final "wrap-up" day.

During many interviews, there were several references to former key teachers who were involved in the original implementation of technology in the school. Interviews with these teachers were also arranged by the researchers and were conducted at the teachers' current schools during the week following the original planned data collection period.

Concurrently, a fourth researcher conducted a review of news articles related to the use of technology in the school and the district as a whole. This search yielded a wealth of data that aided the researchers in developing an accurate timeline of events and served as a check mechanism for the recollections provided by the teachers and

administrators.

APPENDIX B: ICT PRACTICES SURVEY FOR TEACHERS

Based on the responses of 20 teachers (This is one third of the total faculty; questionnaires were delivered to all teachers and three reminders were given to urge teachers to turn the surveys in. Teachers were asked to submit a completed survey to the main school office during the week of interviews)

Table 1: Teachers' feelings regarding different ICT tasks

How comfortable are you with using a computer to do each of the following?	Very comfortable	Comfortable	Somewhat comfortable	Not at all comfortable
Write a paper	13	2	1	4
Search for information on the WWW	5	9	3	3
Create and maintain web pages	1	1	3	15
Use a data base	4	2	7	6
Send and receive e-mail	7	9	0	4
Programming	0	1	1	18
Draw a picture or diagram	3	4	4	8
Present information (PowerPoint or equiv.)	1	1	6	12

Table 2: Frequency with which teachers assigned different types of ICT work

During the past school year, how often did your students on average do the following for the work you assigned?	Several times each week	Several times each month	A few times	Never

Use the World Wide Web	2	3	10	2
Create web pages	0	1	4	12
Send or receive e-mail	0	5	4	13
Use a word processing program	4	2	9	3
Use a computer to play games	1	0	2	14
Use a spreadsheet	1	1	2	14
Use a graphics program	2	0	6	10
Join in an on-line forum or chat room	0	0	0	17
Use a presentation program	0	5	4	13
Use an instructional program	1	0	3	14
Other Uses: Graphing calculator	1			
Other Uses: CAD, CAM, engraving	2			
Other Uses: Digital camera		1		

Several teachers wrote comments indicating that they were unsure about student use.

Table 3: Teachers' rating of ability

	Excellent	**Good**	**Fair**	**Poor**
How would you rate your ability to use a computer?	0	6	9	4

Table 4: Teachers about their use of ICT in classes

Answers based on experiences or polices from the last school year.	**Yes**	**No**
Was student computer use ever evaluated for grading?	10	10
Did you create or modify a Web site with any of the classes that you taught?	2	17
Did you participate as a student or instructor in a virtual course through the Internet/ World Wide Web?	1	18

Did you involve your students in collaborative learning over the Internet/ World Wide Web with students from other classes?	0	19

Table 5: World Wide Web searching restrictions

	No restrictions	Some restrictions	Designated sites only
If you assigned World Wide Web searching, how much freedom did you allow students in locating sites to visit?	5	8	2

Table 6: The portion of computer use in class

	All	Most	Some	Very little
What portion of the computer use in your classes was directly related to the course content?	4	7	2	4
What portion of the computer use that you assigned was done by students individually?	8	5	4	1

Table 7: Using technology to collaborate

	Yes	No
Are you currently using technology to collaborate with other teachers	6	14

Table 8: Frequency of e-mail messages sent and received each day

	More than 12	6-12	1-5	None
How often did you use a computer at home for preparing for teaching?	0	2	10	7

Table 9: Carrying out programming and installation tasks

Have you ever done any of the following?	Yes	No
Made changes to a computer´s hardware	4	16
Updated an application program (word processor, graphics program, etc.)	7	13

Recovered a damaged file	4	16
Created a web site	3	17
Developed a data base	10	10

Appendix C: Documentation

As in the previous report, the names of the schools have been changed in the titles of the documents listed below.

Documents

Documents collected from the school and used in the preparation of this report:

- Proposal for Computer Acquisition (1986). Submitted to the School Board.

  Crocodile Valley Technology Review (1991). Outside review conducted by Dr. Walter Muir, University of Victoria.

  Crocodile Valley Technology Review: 1991. (1991). Second version of Muir report.

  The Restructuring of Crocodile Valley Secondary 1987-1992: Restructuring a Secondary School Using Technology (1992). School-conducted study and report.

  The Crocodile Connection: Interactive Strategies for a Curriculum in Family Management (1994). Masters paper completed by a Crocodile faculty member.

  Crocodile Valley Secondary School Technology Plan 2000-2003 (2001).

  District Wide Professional Development Day (2001). Program of workshops and presentations.

Media Articles

Numerous media articles were found in both educational journals and the local press. These articles span the time period 1986-1998:

- **Educational Journal Articles:**

  School Goes Online to Play Games (1989).

  Visit to Crocodile Valley Secondary School (1990).

  Retrofitting Traditional Facilities (1993).

Local News Articles, Crocodile Valley:

First in Canada: Computers Challenge Teachers Too (February, 1988).

Technophobia Conquered: How Crocodile Valley teachers are Learning to Love the Computer (March, 1988).

This Global Party Line is Busy (March, 1988).

Crocodile Teacher Plans Class from Namibia (Oct, 1989).

High-tech Shop a Big Hit with Students (Sept, 1991).

Electronic Magic Opens Classrooms (Jan, 1992).

Technology is a Friend at Crocodile (March, 1994).

Tech Class a Place of Discovery (March, 1994).

Remote Controlled Boats

High Speed Air

The Robotic Arm

Internet at all High Schools (Aug, 1995).

Froese Leaving the District Helm (June, 1996).

Crocodile Valley Sets Out Video Project (July, 1996)

With a Little Help From His Friends (Oct, 1996).

Forging Links Around the World (March, 1997).

The Leaders in High-tech (March, 1997).

Former School Superintendent Earns Achievement Award (May, 1997).

Local News Articles, Ace Slope Secondary (A district school opened in the early 90s based on the success of Crocodile):

Innovative and High-tech, New School Will Fit In (June, 1988).

Ace Slope Opens New Lab (Nov, 1991).

High School Boasts Latest in High-tech (Nov, 1991).

New Schools Taking Shape (May, 1992).

A School to Write Home About (Feb, 1993).

The $34 Million High School of all High Schools Opens to Students

Tuesday (Feb, 1993)

New Era Begins (Feb, 1993).

School of the Future (Feb, 1993).

A School of the Future That's Open Today (May, 1993).

Computer Keeps Tabs on Students (Jan, 1994).

Divers Link-up with Students (April, 1994).

The Future Has Landed (March, 1995).

New Principal Feels at Home (Sept, 1995).

Ace Slope to be Hub of On-line District (April, 1996).

Prince Charles to Tour 'One-of-a-Kind School' (March, 1998).

Visit Slope on the Web (March, 1998).

Voice From Space (Oct, 1998).

Local News Articles, Topper Secondary (A district school opened in 2000 based on the success of Crocodile and Ace Slope):

Planning on Track for a New High School (Feb, 1996).

One Last Project to Direct (August, 1996).