THE INTERNET AS A TEACHING AND LEARNING TOOL

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Executive Summary

The purpose of this project was to explore ways in which the Internet could be used in the classroom. The Internet is a recent technological innovation; many of its uses for the classroom are yet to be uncovered.

As the project evolved, the questions concerning its purpose became more precise: Was the Internet to be used simply as a resource? Were the students meant to be instructed on how to use the Internet? Were the students meant to become computer literate? How comfortable did teachers have to be with the Internet or computers in general to make good use of the Internet?

A literature search conducted mainly on the Internet revealed that papers were being written relative to: a) standardizing the terminology used; b) identifying the current use of technology in the schools; c) identifying the challenges to be met in order for widespread use of technology to be achieved; d) outlining some national/provincial strategies to expand the use of technology in education; and e) assessing the impact of technology on student performance.

This project fits into the category of "identifying the challenges to be met in order for widespread use of technology to be achieved". However, its purpose is closer to the actual teaching and learning going on in the classroom on a daily basis.

For purposes of this project, the use of the Internet was focused on mathematical problem solving at the grade three level. Problems and units found on the Internet were linked to the provincial curriculum (*Mathematics: A Curriculum Guide for the Elementary Level*, Saskatchewan Education, 1992). A variety of instructional strategies (e.g., manipulatives, discussion, direct teaching) were used, as well as rubrics to assess students' problem solving abilities.

The project revealed that the Internet is a formidable resource, offering many sites containing a variety of interesting and challenging problems. Due to the wealth of problems offered, the project focused on the Internet as a resource. The project also revealed that teachers need not be proficient in using the Internet and can easily access and use it as a resource.

Further, the project has had a dramatic and positive effect on the researcher's use of problem solving in the classroom.

A short handbook was developed in the hopes that teachers unfamiliar with the Internet will find it easy to access and use.

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Introduction/Background

From 1991 to 1996, I spent five years at Saskatchewan Education as a curriculum writer. When I came back to the classroom at St. Francis school (a community school), I found that many things had changed. One of the more obvious changes was the number of computers in the schools. Our school boasted a computer lab with approximately twenty-five computers. Some classrooms also had a computer, usually at the back for use by students. The staff room was equipped with a computer and printer for teacher use. The office and the library were computerized. The principal had a computer in her office and was more often than not seen working at it. These computers were all connected through a network. I spent the first few months back in the school system learning how to use them.

While at Saskatchewan Education my writing had been done on computer. There I had learned to use a word processor and communicate through electronic mail. When I left, the computer that I had been assigned to for five years was no longer able to handle all the new technological innovations available, such as Windows and the Internet.

During those first few months at school I spent a lot of time figuring out how the network operated, what was available on it, and how to make this accessible to my students. This network was, of course, very different from the one I had learned to use during my years of writing at the department of education. Each school in our school district has a technology representative to help other teachers and look after minor maintenance problems. Every day I would approach this colleague with a new question or concern as I learned how to use this computer network. I discovered that there were many programs which supported the curriculum and which I would be able to use with my students. Each student and staff member had automatically been assigned a unique user ID at the beginning of the school year. After a few months I finally decided the time was right to take my grade three students into the computer lab. I felt slightly guilty for having taken so much time to learn this technology and did not want my students to loose out by being away from the computer any longer. I then looked at the computer

schedule and found to my great surprise that I had a great choice of times to choose from. In other words, the computer lab wasn't being used much by other classrooms. I had mistakenly thought that all the other teachers would have been familiar with this technology and their students would have been making good use of the computers. But not so! As it turned out, I was now one of the more knowledgeable people on staff, and when our technology representative was asked to give a workshop for our teachers in November of that year, I was also asked to lead a section; and when our technology representative was transferred to another school at the end of the year, I was asked to assume this responsibility.

During that first year, my students were able to learn how to use a simple word processor to write and edit their stories. They used reading programs appropriate for their grade level and developed their reading comprehension. They were able to use electronic versions of mathematics manipulatives to increase their understanding of problem solving concepts and to develop their skills. Through these programs they also learned basic computer operations and basic keyboard skills: they learned how to save their stories, to retrieve them, to edit them, to use a mouse, to print, etc.

We were told many times that we would soon be able to go to the Internet. Everybody was excited, but I had some doubts about the use of this new technology in our schools. What was it supposed to do? I was told by many enthusiasts that I would be able to go anywhere in the world, that I would have access to all kinds of up-to-date, pertinent information. How? Through my spouse I had access to the Internet, but I had found it time consuming and not always rewarding. I applied for a research grant through the Dr. Stirling McDowell Foundation to help me learn how to use the Internet.

In my second year at school we were given access to the Internet. Students and parents had been told this was coming and students could barely wait to get on. Most teachers reacted by panicking because they didn't know how to use the Internet. Teachers were given a half day inservice on the basics: how to get to the Internet, to search, to write an address, to send electronic mail. Pressure from the students and security concerns from the parents and staff made it imperative to move fast. An *Acceptable User Policy* form was devised and those teachers wishing their students to use the Internet sent it home for parents and students to read and sign. I decided to investigate the Internet further before actually allowing my students access to the Internet.

The Internet as a teaching and learning tool is the title of this research report. I toyed with the idea of calling it “How I Got on the Internet Highway and Promptly got Lost!” or “Personal Road map to the Internet”. A sense of humour is often required to learn new tools, especially those which can be very useful but at the same time very frustrating - useful because a lot of good information exists, which was not readily accessible before the advent of the Internet; - frustrating, for the same previously stated reason, because there is a lot of information, some of it useless, and it is not always easy or it is time consuming to sort through and find this information.

When I started investigating, I had been on the Internet a few times only. I basically knew how to get to the Internet from where I was (at home), how to type in the address of a web site already known to me, how to initiate a basic search, how to use the “back” and “home” buttons, how to save, how to print, how to make and use a bookmark. This is simply to illustrate for the reader my starting point and possibly where I now stand.

Most computer users today have learned how to use computers in a somewhat haphazard way: they have learned only what they needed to learn (through introductory courses or reading the manuals) and have increased their knowledge as needed or because of specific interests. Therefore very few people would be expert in all areas of computer use.

Questions/Quest

The research question which I would like to answer is the following: How can teachers use the Internet as an effective teaching and learning tool? I will take for granted that most teachers are interested in the uses of the Internet in the classroom. It is impossible to be alive today and not realize that computer technology is expanding at an incredible rate or that the impact of this technology is affecting our lives in many known and unknown ways. Many statements have been made regarding the Internet, outlining its good and bad features.

The super optimists feel that the Internet will solve all the problems related to teaching and learning: students will become independent learners as they search for information regarding research projects; tutorials and classes offered on the Internet will allow the curriculum to be tailored to each student’s needs; students will have access to up-to-date information; students will be able to converse with students from all over the

world, thereby fostering unity and peace in the world; students will be able to do their schooling in the privacy of their homes, thereby saving the costs of building and maintaining schools; students will be able to access the knowledge of experts, thus making the teacher nearly obsolete.

The naysayers believe that the Internet is simply a toy and that students can be led astray, that students will not acquire basic reading, writing and mathematics skills usually learned in the elementary school, the Internet use in the classroom is a passing fad and cannot replace the role of the teacher in the classroom.

The truth lies somewhere between these two poles. Teachers need to become familiar with this new technology in order to help students make the right decisions about its uses. What better way to do this than for teachers to take an active role and learn how to use the Internet in their classrooms?

As I thought more about the research question I realised that it was vague and I wasn't sure what I wanted to do. Did I want to use the Internet simply as a resource, such as books or manipulatives? Was I looking for sites which my students could access and work on? Was I trying to make my students computer literate? Was I taking into consideration the fact that a teacher has to have some familiarity with the technology in order to use it?

I started using the Internet. Having spent many years in libraries, I have developed a fondness for its system of cataloguing and finding resources. I like the top-down approach or the tree and its many branches analogy where I can start with a general topic and physically find my way to a group of books related to any obscure topic of my choosing. Some information may be cross-referenced and may exist in another section of the library, but generally I can count on finding the exact resource I am looking for and others very similar in one physical place in the library. That way I also know that I have found all the resources related to my topic. My linear and sequential type of brain was therefore hoping to work the same way once it embarked on its voyage on the information highway. What a surprise and what discomfort to discover that not only does the Internet not function in this manner but that I was entering this Internet/library by one of its many millions of doors instead of the one or two doors which libraries usually have. And how was I to find all the resources related to my particular topic in one place?

Over the years I have developed many problem solving skills and decided to approach the use of the Internet in this manner. My objective was to make using the

Internet as efficient as possible for my purposes. I decided to narrow my search on the Internet to mathematical problem solving for the elementary grades.

Literature Search

The Internet being a recent technological reality in education, I wanted to know if anybody else had written in answer to the questions that I had. I wanted results of recent research. I wanted research specifically related to the use of the Internet for teaching and learning. Much of the literature concerns computers in general, and with the rapid advances in this technology, I felt that any paper more than seven or eight years old would not be relevant. Since information on the Internet is updated regularly and is recent I decided to research the literature using the Internet. I quickly found the ERIC database (http://ericir.syr.edu/) on the Internet and started the search.

Much of the literature that I found referred to the use of technology rather than simply the use of the Internet. The Internet being a subset of technology made the research relevant. Some of the papers written referred to the use of the Internet in particular. Since this is a relatively new field of educational research, many of the papers related to the following issues: standardizing the terminology used [3], [8], [11]; identifying the current use of technology in the schools [3], [8], [11], [19]; identifying the challenges to be met in order for widespread use of technology to be achieved [3], [4], [5], [6], [7], [8], [9], [11], [12]; [13], [14], [16], [19], [20]; outlining some national/provincial strategies to expand the use of technology in education [2], [3], [8], [10], [15]; assessing the impact of technology on student performance [1], [3], [14], [17], [18], [19], [20], [21].

In any new area, it is crucial that the terms used be defined; in this case, terminology refers to terms associated with the Internet specifically and the computer generally. It also refers to the terminology used in this relatively new field of educational technology. Some researchers define the terms they use, others assume the reader will know what the terms specifically refer to. Heide and Stilborne [11] have compiled a glossary which is very useful for the layperson.

Over the last few years, many agencies have investigated the current use of technology in the schools. “Surveys suggest that the average school still makes limited use of computers and substantial numbers of schools have very limited access to technology of any kind.” [8] “In the education systems of the advanced industrial

countries, computers are currently utilized mainly in three roles: first, the traditional one as a means of ensuring that students acquire a minimum level of computer literacy; second, as a means of supporting and enriching the curriculum; and third, as a medium for interaction between teachers and learners, between learners and between teachers." [3] "A distinction needs to be established between technologies that extend or replicate the classroom model, and those that fundamentally change the instructional paradigm". [3] The computer can be seen as a tutor, rather than a tool, or a tool rather than as a tutor. "Buying the technology, plugging it into a school, and thinking that things will improve is not enough." [3] "Student access to computers in school is measured by frequency of computer use. Often researchers use the ratio of computers to students of the level of spending as an indicator of access. Yet computers may be sitting in closets, or in classrooms unused." [19] "Computers and supporting technologies have any number of uses. These are generally of five types: support for individual learning, group learning, and instructional management; communication; and administration. Applications to individual learning include drilling students on particular skills, using CD-ROMs or the Internet to find resources not available in the school, communicating with experts, word-processing, providing assistance in computations, and demonstrating simulations of mathematical or scientific concepts. Group learning applications include using e-mail to support group communication, using presentation software to allow group presentations on a project, and providing collaboration in collecting and analyzing data. Applications to instructional management include integrating standards and assessments, managing student portfolios, and developing individual student learning plans. Communications applications include communicating to remote locations such as rural schools and improving communication among students, teachers, and parents. Finally, applications to administrative functions include supporting attendance and accountability functions." [19]

The following chart outlines how Heide and Stilborne [11] see the Internet being used in the classroom.

Figure 1: Internet in the Classroom

By observing teachers and students in schools, it is perhaps easier to identify the challenges to be met in order for widespread use of technology to be achieved. The biggest challenge relates to the person who is on the frontline when it comes to using the Internet in the classroom: the teacher. Regardless of how much funding is accorded to the purchase and maintenance of computers, the Internet's and the computer's use in the classroom is completely dependent on the teacher. Along with curriculum reforms the teacher is the one to implement changes in the classroom. Through my work as the technology representative in our school, I have had many opportunities to work with and observe teachers in their use of computers. Teachers in our school have had access to a variety of in-school and system-wide workshops and individual peer coaching. Still a significant number of teachers still cannot log on to the computer while others are assigning interesting research projects for their students through the use of the Internet, and communicating with their students through e-mail. "Computer literacy is still, however, a major problem for preservice and inservice teachers. The gap between the ones that have and the ones that have not the basic skills is highly perceptible in the teaching profession, whether at the entry level or later in one's career." [3]

New models for teaching and learning are promoted in all study areas, at all levels of the education system. That is basically what has been at the heart of curriculum changes in the last ten to fifteen years. As the paradigm shifts from the old teaching and learning model of teacher centred instruction, passive absorption, individual work, teacher as the expert, static and prescribed learning to the newer model which is learner centred, requires learner participation and team learning, uses the teacher as a guide and offers dynamic learning to learn, the use of computers and the Internet as tools begins to make more sense. Students become empowered as learners, their motivation is enhanced, team building skills are developed, learning is enhanced through sharing, the framework for learning is more adaptable to a fast-changing world, resources for learning are replaced by online link to the real world, resources can be

adapted to immediate learning needs and skills are developed for the information age. [3]

"Traditional classroom teaching methods related to mathematics have been associated with direct teaching, workbook or textbook seatwork, drill and practice activity, homework review, blackboard demonstration, and so on--a positivistic behaviourist model. Teachers who generally teach mathematics this way will most likely use technology similarly." [20]

The challenges which are still being addressed regarding curriculum changes in the last two decades are the same ones being addressed now as the education community strives to empower students through technological literacy.

Brand [4] identifies some key elements for training teachers in instructional uses of technology: time, variety of needs, flexibility in professional development opportunities, support through experienced teacher, collaborative development, remuneration and teacher recognition, sustained staff development, linking technology and educational objectives, intellectual and professional stimulation, clear administrative message." [4]

Having viewed the literature, I realized that very little applied to the questions I had asked. The questions that I was asking would fit under the category of "identifying the challenges to be met in order for widespread use of technology to be achieved". Even though some of these challenges have been identified, very little seems to have been done in the area of integration of the web and the day to day teaching and learning going on the classroom. In other words, once I find things on the Internet how do I use them in the classroom?

Methodology

In this section, I will describe my journey through the web, what I found, what I learned and what I did with what I found.

Journey through the web

On my first trip I decided to visit *Math Central* (http://MathCentral.uregina.ca/) and proceed from there. I was looking for problems that I could use in my grade three classroom, ideas on how to do problem solving in the classroom, sites the students

could access themselves, in fact anything related to my topic. I wasn't sure what I would find.

Here are some of the things I did find:

Math Central had many links to other mathematical sites. As I proceeded from *Math Central* to another site, I discovered this new site also had links to similar sites. In fact, every time I visited a new site, I discovered many links to other similar sites. I quickly became lost: I was trying to proceed from one site to another in some kind of linear order, wanting to come back to my original site to start with a new link again. I was worried that I would miss some good sites while I travelled haphazardly through the Internet. At some point I had to admit that there are too many sites for me to visit and, that I would have to risk missing a good site. On the other hand, as I visited site after site, I began recognizing some sites: I had either visited them previously or they had been listed at another site.

I found myself easily distracted from the task at hand, which was to find sites related to problem solving. I was travelling through numerous math sites and was finding many items of interest but not necessarily related to problem solving. Then, after surfing for a couple hours, I would usually find myself full of new ideas, lessons and unit plans, but with very little that was related to problem solving.

There are different kinds of sites in existence: sites for teachers, sites for parents, sites for students, sites whose sole purpose are to list other sites related to a specific topic, sites developed by publishing firms (math textbooks), sites developed by teachers, sites developed by non-profit agencies, such as SaskEd, University of Regina Mathematics and Statistics Department, sites selling a product, etc. (See appendix for examples of these sites.)

The thing which really surprised me was the time it took to do this. Up to this time I had used approximately two days (one full day and two half days) which the grant from the Dr. Stirling McDowell Foundation allowed me to do. After these two days, I did not feel I had accomplished very much: I was still moving haphazardly through the Internet; I had to wait, sometimes a number of minutes, to reach a site; I often forgot to bookmark an interesting site and then had to spend time finding it again; the computer would sometimes inexplicably freeze up; my Internet connection would sometimes be disrupted by an incoming telephone call; I wasted valuable time until I found out that Internet addresses are sometimes case sensitive (most times it does not matter if upper

or lower case letters are used in the address, but sometimes it does). How could anyone expect an overworked teacher to do this on his or her own time, snatching a few minutes here and there?

What I learned

To summarize my first few trips on the web:

1. There are too many sites around and it is possible that I will miss a really good one.
2. Some sites keep reappearing in lists or links.
3. It is extremely easy to get side-tracked, but what a wealth of information there is.
4. There are many different kinds of sites on the Internet, all with their own purpose.
5. Much valuable time can be wasted while becoming accustomed to using the Internet.

However, having said all this, I did find many useful sites. Of course, there are many out there waiting for me to discover them. And, having resigned myself to the fact that I did not need to find every possible site related to problem solving, I needed to know how to use these sites and problems in my classroom.

After I had started working on this research project, I was asked (along with seven or eight other teachers from my school division (Regina Catholic Schools)) to participate in a joint project with teachers from the Regina Public Board. This project was about using rubrics and benchmarks to assess students' performance in solving mathematical problems. The first part of the project was done in conjunction with a presenter whose company publishes problems and benchmarks for these problems. Samples of problems, their benchmarks and a rubric can be found at his website (http://www.exemplars.com). Through the workshops and work sessions related to this project I learned how to make rubrics and establish benchmarks for problem solving. This fitted in perfectly with my research project.

What I did with what I found

The Saskatchewan curriculum guide [22] states that: "The belief that 'learning is limitless for learners who can solve problems', supports the initiative to have problem solving as a central focus for the curriculum." (p. 5) It further explains the three aspects

of problem solving: understanding the problem, planning a solution strategy and executing it, and reflecting on what was done.

This main focus of problem solving is a relatively new one in curriculum guides throughout the world. It has come as a result, in the last twenty years, of rethinking what it is we want students to learn: in simple terms, do we wish them to learn how to do computation or do we wish them to know how to think, solve problems and apply the skills they have learned?

This new focus obviously changes the way in which we teach and learn mathematics. No longer are we solely interested in the rote memorization of basic facts and formulas. They still have a place in mathematics but not the prominent one they once had. We now need to show students how to understand problems, how to solve them (strategies) and how to learn from this process (reflection).

Further, the curriculum guide suggests using a variety of problems: translation problems, which are usually word problems related to mathematical operations; process problems, where the process of solving the problem is as important as the solution itself; and realistic problems, problems possibly ill-defined, which may not have a solution. Textbooks offer an abundance of translation problems, you almost might think no other kind exists! Often realistic problems are by their very nature related to the students and arise out of the classroom itself. Therefore I wanted to find process problems.

I found many sites offering problems to solve, translation and process problems. I started collecting interesting process problems. Some sites offered weekly or monthly problems for various groups with options for students to send their solutions to these websites; solutions would appear the following week or month. Most of these sites also offered archives of problems previously offered. Some sites offered a student worksheet every week which focused on a particular mathematical or non-mathematical theme. Other sites offered model units with lesson plans, activities, etc.

As a teacher I have always been interested in what students are thinking. For students to become better problem solvers they need to reflect and discuss within a group their thinking as it relates to the problem at hand; they also need to feel safe enough to risk sharing their ideas. Therefore I always introduce problems to the group through the use of an overhead projector. I typically reformat the problem or personalize

it for my students to make it easier to read and understand and to make it more interesting.

First example: A problem

One of the problems I presented to my students I found at The Math Forum (http://forum.swarthmore.edu/dr.math/). It was an elementary problem of the week for the week of September 8-12, 1997. It appeared as follows:

> The Fighting Frog wants to decorate one of the math classrooms with all the whole numbers from 1 to 100, inclusive. The plan is to cut out all the ones, then all the twos, etc. How many of each of the ten digits will the Fighting Frog need? What if the decorations went through 1000?

I personalized and reformatted the problem in 18-point font to make it easier to understand, then presented it on the overhead.

Let's Decorate!!

Mrs. Hanson wants to decorate the classroom with all the numbers from 1 to 100. The plan is to cut out all the ones, then all the twos, etc.

How many of each of the ten digits will Mrs. Hanson need?

Explain how you found this out.

Figure 2: Let's Decorate!!

I explained to the students that they would be working on this problem with a partner, that it was not a problem that they would be able to solve in a few minutes, that they might find it hard (but that was O.K.), that they would have to think and discuss with their partner how to solve it, then they would have to explain to me how they solved it. I also explained that we were looking at new ways of doing math and looking at new ways of seeing how well we were learning to be problem solvers (we would be looking at a rubric).

First they needed to know what the problem was asking them to do. We read it together out loud. Why were we decorating the classroom with numbers? Why weren't we cutting out 100 numbers? We discussed the fact that all numbers are made up of combinations of the digits from 0 to 9, the difference between numbers and digits. We talked about an example: if we wanted to cut the digits for the number 52, we would need to cut out a 5 and a 2; if we wanted to cut the digits for the numbers 52 and 75, we would need to cut out two 5s, one 2 and one 7. We related it to cutting out letters to make out words on the bulletin board: when the teacher wants to write the word WELCOME in big letters, she needs to cut out one W, two Es, one L, one C, one O and one M. At this point most students realised the enormity of the problem: they understood what the problem was but did not necessarily know how to solve it.

We moved on to the next step in the problem solving process. The students were given pieces of blank paper, assigned a partner and asked to start thinking and discussing. They were reminded that they might still find it difficult but that it was O.K. They were told they would have about thirty minutes to work on this. They were told that there might be more than one way to solve the problem. Wouldn't it be fun to see the different ways to solve the problem?

As the students started to work, I wandered around the classroom, smiling and listening. I answered questions without revealing the solution, I encouraged students who were having trouble getting started, I asked what they were thinking. Many pairs were working on a strategy, some hesitantly, some confidently. I made sure they knew it was permissible to be having difficulties, the first ones to finish solving the problem would not necessarily be the ones to come up with a correct solution or the best way of solving the problem. I made sure they knew the process itself was very important and that by discussing how to solve the problem would make them better problem solvers in the future. At one point two students got up and started discussing the problem while

looking at the large hundred chart on the wall. I pointed out that I was impressed by the number of different ways students were using to solve the problem. In fact I pointed out the two students using the hundred chart. Another pair, which had been having difficulties, came up and started discussing in an animated way. Other pairs, who were already in the process of solving the problem, briefly listened then returned to their work. I was pleased to realize that all the students were focused on the task at hand. After forty minutes it was recess and I collected the papers.

I was eager to start looking at their papers. I wasn't simply going to assign a mark, but I was going to look into how my students were thinking. Given that they were working on a blank sheet of paper, there was no structure there for them to follow or to confine them. The papers therefore looked quite messy and were sometimes difficult to read through.

I used a rubric from *Exemplars* (http://www.exemplars.com) as my starting point. It assesses three areas of problem solving: the understanding of the problem, the strategies, reasoning and procedures used to solve the problem, and how well the reasoning and solution are communicated. It also has four levels of competence from the novice, moving through the apprentice and the practitioner, to the expert. I rewrote this rubric in terms my students would understand (figure 3).

CRITERIA FOR EVALUATING STUDENTS' PROBLEM SOLVING ABILITY (GRADE 3)

Revised September 1999

	Understanding	Planning and Executing	Reflecting
4	• Understands the problem	• Uses good strategy • No errors • Checks to see if the answer makes sense • May find more than one answer	• Very good, clear explanation • Uses math words and signs, or charts or drawings to explain
3	• Understands the problem	• Uses a strategy that helps to solve • Correct answer • Doesn't need help	• Good explanation • Uses math words, signs, charts and/or drawings to explain
2	• Understands only part of the problem	• Uses a strategy that helps but does not solve • Needs a bit of help or hints • Some parts are correct • Some errors • No complete answer	• Explanation not complete, not easy to understand
1	• Doesn't really understand	• No strategy • Uses a strategy that does not give the correct answer	• No explanation • Explanation not related to the problem

		• No reasoning • A lot of errors	• No charts or drawings • Charts or drawings not explained

Figure 3: Rubric

The first time I introduced the rubric to the students was after they had worked on the ‘digits’ problem and before I handed back their solutions. I did not want to overwhelm them that first time. I put the overhead back up and we discussed and solved the problem together. Then I put the rubric up on the overhead projector and explained it. I made sure they understood that this was a tool for helping them become better problem solvers and that from one problem to another it is quite normal to go up or down in this assessment. It was presented in a positive manner. I then handed back their solutions along with the rubrics. They were then able to compare their solution with the solutions discussed in class a few minutes earlier.

Most of the students did not finish the problem because of time, but it is still possible to see the kinds of ideas (or lack of them) they came up with. The following examples demonstrate this (figures 4 - 9).

Figure 4: Student 1 and Partner

Student 1 and her partner (figure 4) listed the numbers from 10 to 100 and offered no explanation. They were assessed as novices in all three categories because they did not appear to have any understanding of what the problem was asking them to do. They did use a strategy (listed the numbers) but it did not help to solve the problem. If they did have some ideas they did not communicate them. On the first line of numbers something had been previously written then erased but I could not tell what it was.

Figure 5: Student 2 and Partner

Student 2 and his partner (figure 5) were assessed as apprentices. They understood what the problem was asking, they used a strategy which allowed to get some correct answers and there is some explanation though difficult to understand of how they attempted to solve the problem.

Figure 6: Student 3 and Partner

Figure 7: Student 4 and Partner

Students 3, 4, 5, 6 and their partners (figures 6, 7, 8, 9) were assessed as practitioners, at least in the understanding of the problem and the strategies they used to solve the problem. Even though students 3 and 6 offered no explanation it is clear from their work what their strategies were. Which brings us to the aspect of communication in

mathematical problem solving. My colleagues and I (on the mathematics rubrics team) were divided on what communication meant: some insisted that full sentences had to be used, while others agreed that a good diagram can be just as eloquent in conveying the message. We finally referred to the curriculum guide to resolve the issue. “Answers can be displayed differently depending upon the type of problem. Help students to display answers in a visually appealing, precise manner, e.g. Use complete sentences which include appropriate units and mathematical vocabulary. When displaying data in a graph, table, or chart form, give a complete explanation of the results.” [22] (p. 512). “Encourage students to use a variety of media to communicate problem solving procedures and results, e.g., models, manipulatives, diagrams, graphs, charts.” [22] (p. 513)

Figure 8: Student 5 and Partner

No student received an expert assessment. When the students and I discussed the rubric in general we agreed that an expert paper had to be “WOW”, it had to be really good!

Over the last two years the rubric itself has changed many times.

Figure 9: Student 6 and Partner

Second example: A unit

I went to *Math Central* (http://MathCentral.uregina.ca/) and found the following site published by the Stewart Resource Centre (http://142.3.219.38/RR/database/RR.09.98 /ferre/right.html). I decided to use and adapt the unit called: “Money Talks Canadian Money” written by Wilna Ferre and Cora Gaillard to teach about money but also to integrate other aspects of mathematics into this unit. Being focused on problem solving, I decided to start the unit by using the following problem:

“Andrew has three coins and Susan has five coins. Who has the most money?”

This problem might be considered tricky and unfair but it is used only as an introduction to the unit and is not used for assessment purposes. After about five minutes of deliberation students realised that the answer was dependent on the coins themselves, not how many there were.

“What are all the possible coins which could be used?” As a group we proceeded to list all the possible coins which could be used, how much they were worth, what they looked like, their colour and their size. We put them in ascending order of monetary value. After much discussion we chose to omit the 50 cent piece from our list since it is not a common coin in use. Therefore we had six coins: the penny, the nickel, the dime, the quarter, the loonie and the toonie. We discussed the significance of their names and related it to their monetary value. We discussed the fact that the toonie was a very new coin, only a couple of years old and that the loonie was also a new coin though older than the toonie. During this time many students brought money to show at school. We then discussed the notation used to write about money. The students were quite familiar with the symbols for cents (¢) and dollars ($).

“What are the three coins that Andrew could have?” We then decided to make a list of all the possible coin combinations that Andrew could have had. Starting with three pennies, then two pennies and a nickel, and working our way up to three toonies, we came up with fifty-six possible combinations. Were we ever surprised! At this point we all agreed that it would be a super big job to find all the possible coin combinations for Susan’s five coins!

“What is the total amount of money that Andrew could have?” So we decided to find all fifty-six sums and these ranged from 3 cents to 6 dollars. The students found it very

easy to add up the value of three coins: for example, they were able to add a loonie, a quarter and a dime very easily to arrive at $ 1.35. The one difficulty they had was using the appropriate notation. Up until now they had been used to working with cents or dollars but not both at the same time. I explained that we would no longer be using the ¢ symbol for cents. Having explained that one hundred pennies are equal to a dollar, they accepted the new notation. We further discussed how this resembled our base ten number system with pennies being the ones, dimes being the tens and loonies being the hundreds.

“What’s the smallest amount of money that Andrew could have?” “What’s the largest amount of money that Andrew could have?” “Were there different combinations of coins which would give the same sum?” We then put these sums in ascending order of monetary value. We discovered that there were only two different combinations of coins which yielded the same sum. How interesting!

This work took us the better part of a week. It grew out of that first question. During this time the students had done a lot of mathematics: they had identified coins, they had learned its notation, they had practiced adding coins mentally, they had made systematic lists, they had compared numbers in terms of place value, they had solved problems arising out the data generated, they had formulated questions to be answered using the data. And we were just beginning this unit!

In the next activity I read the book *Alexander Who Used to Be Rich Last Sunday* (Viorst, 1987) and asked the students to figure out how much money Alexander had left at the end of the story. The students were given a piece of paper to help them. It was interesting to see the different strategies used to solve the problem: some students subtracted as the story progressed while others chose to add everything up and subtract at the end. I was impressed, we hadn’t discussed any of this previously. We discussed the strategies used and students gave their preference as to which strategy they preferred and why.

The students loved this activity so much that I made up a few more stories about Alexander and his allowance. The students then suggested that they would also like to write stories similar to Alexander’s.

In groups they worked on their stories for about fifty minutes then handed them in. The next day, I read the stories while the students figured out how much money was

left. This was a lot of fun. Some of the stories were not finished but we were still able to use them to solve problems. There were six groups, following are their unedited stories:

Figure 10: Group 1 Story

Figure 11: Group 2 Story

Figure 12: Group 3 Story

Figure 13: Group 4 Story

Figure 14: Group 5 Story

Figure 15: Group 6 Story

During this activity we looked at the loonie being equal to one hundred pennies and subtracted pennies from pennies but we could also subtract from $1.00 using the decimal notation. The word decimal was only mentioned in passing and was described as another way of writing fractions. Therefore students were able to do both of the following computations: $1.00 - $0.13 = or 100 - 13 =. The students also had opportunities to review subtraction and addition with trading.

In our next activity we looked at equivalents such as 1 dime = ? nickels, 4 quarters = ?, show as many ways as possible to make $1. 28. We proceeded from easy to difficult and students eventually made up their own questions and answered them. At this time I also used a problem sheet which I had found at another site (http://www.rhlschool.com/math3n6.htm). Since it related to U.S. coins I used this sheet as a resource, adapted it and did not give copies to students or use it as an overhead.

Our next activity took us to a lunch menu. We took the menu (Lunch for a Bunch) offered in the unit. This was placed as an overhead and students worked in groups. We started off by establishing a meal and finding out its cost. We then moved on to the problems offered in the unit where students were not always told what had been ordered but were told how much the meal cost. They were involved in adding and subtracting, making change, estimating. They loved it!

In the next activity the students did a number search (Where do Canadians Keep Their Money?) as offered in the unit. Since my students were not very proficient in multiplication, I changed the computation exercises to reflect the arithmetic they were working on at that time.

To finish the unit students were given one more problem found on the web. It was found at (http://www.srl.rmit.edu.au/mav/PSTC/problems/pom8_97.htm) and was adapted.

Most of the activities in this unit were problems which students had to solve. Many of the objectives from the numbers and operations strand of the curriculum guide were met as well as some related to measurement and data management. But the focus of the unit was problem solving! It was a pleasure to teach this unit and watch the students work. The students loved the challenge of problem solving.

Other examples

As I travelled along the Internet I encountered many interesting sites. One which I found particularly interesting was called *This is MEGA Mathematics* (http://www.c3.lanl.gov/mega-math/). It was interesting because it allowed students to explore problems from higher mathematics but at their own level. We chose *The Most Colorful Math of All* in which students were introduced to the mathematics of map colouring. The unit started with a story, followed by various activities and maps to colour. The instructions to the teacher were very easy to follow and included a section (for the teacher) on the mathematics behind the maps (in layperson's terms). The students loved this unit as it allowed them to do mathematics while colouring! By the end of the unit, the students were able to recognize and make two-colour maps; they were quick to recognize if a map would require four colours instead of three; they had devised strategies to work effectively (such as starting in one area instead of filling in areas randomly, putting down coloured marks or circles before actually colouring). At the end they were given a map of Canada and a map of Regina to colour. This unit is an excellent example of a series of process problems. The learning objectives covered by this unit are the ones in the problem solving strand of the curriculum. It does not appear to have learning objectives found in the numbers and operations strand, the geometry strand, the data management strand or the measurement strand. But as a tool for developing problem solving skills in students it is excellent!

Another site (http://www.rhlschool.com) offered teachers the free use of worksheets which helped to teach particular problem solving strategies. For example, one sheet (http://www.rhlschool.com/math3n1.htm) is about identifying missing or extraneous information. For instructional purposes this sheet was presented as an overhead and each bit of information not required was identified and crossed out. The students were then able to solve the problems mentally.

Conclusions

As I wrote this report I became aware that this whole project has been an exercise in problem solving and I have been through the three parts of the process many times since the beginning of the project. But I had almost forgotten how important this final reflection, writing the report, is.

My original question to be answered was: How can teachers use the Internet as an effective teaching and learning tool? Other questions which came up: Do I want to use the Internet simply as a resource, such as books and manipulatives? Am I looking for sites which my students can access and work on? Am a trying to make my students computer literate? Am I taking into consideration the fact that a teacher has to have some familiarity with the technology in order to use it?

I discovered that the Internet can be used as a teaching and learning tool. The problems which I found and used were interesting and were related to the curriculum. I used them in the manner advocated by the curriculum and I was able to assess my students' work by incorporating some new knowledge I was gaining regarding rubrics and benchmarks. I became more proficient at teaching mathematics according to the philosophy of the curriculum as detailed in *Mathematics: A Curriculum Guide for the Elementary Level* [22]. The students and I developed an enjoyment in solving problems.

I used the Internet mainly as a resource for problems and ideas. I have not found sites for problem solving where I would feel comfortable letting my students work. As grade three students they are at the beginning of their association with computers. As I become more comfortable with the Internet this area will probably be one which I will explore with my students. Making my students computer literate and helping them use the computer as a tool for learning naturally go hand in hand. When I reflect on my use of the computer in my teaching, I realize that one part is making students comfortable using the computer while a major part is using the computer as a tool, such as in using a word processor to write, doing activities which enhance reading comprehension. Allowing students access to the Internet is another step in using the computer as a tool.

How knowledgeable does a teacher have to be about computers in order to use the Internet? A minimum of knowledge is required: the teacher must be able to log on to a computer, know how to use a mouse and navigate to some extent. Teachers with very

little knowledge can use the Internet: computer literate colleagues are usually more than willing to help others set up their account, and set up a path to the Internet. Reading books about how to use the Internet are not as useful as the “guess and try” method. I was able to find more information than I could possibly use with my small store of knowledge.

Since problem solving is a process oriented activity as opposed to a result type of activity these are some observations which have surfaced through using a variety of problems in the classroom:

- it is important that the problem be interesting and fun to solve,
- the problem presented may be too difficult for the students: we then proceed to solve it as a class,
- it is acceptable for the students to know that the teacher may make mistakes in solving problems or may not be sure how to solve the problem,
- it must not be perceived as a threatening activity,
- it is perfectly acceptable to need help,
- once a month a problem was sent home to be solved with the help of parents or guardians: this reinforced the importance of problem solving and made it very interesting for the students and their families,
- problem solving is a process, not all problems need to be solved individually or need to be assessed: often the process itself is more important than the product. We need to learn how to assess the problem solving process rather than simply its solution.

This project started with an idea in mind: to learn how to use the Internet and write a handbook for teachers, but the task began to change immediately. It became a personal professional journey and ended up turning my mathematics teaching on its ear. After exploring problem solving with my students over a period of two years, problem solving has become the real focus in my mathematics classes. It has allowed me insights into my students’ thinking and because of that I believe I have become a better teacher allowing differences in learning styles and rate of learning and allowing students to feel success and enjoy solving problems. It has opened other doors for me to grow professionally.

As a final word I would like to relate the following story. Robbie is a young student in my classroom experiencing difficulties in language arts and mathematics. He is a year older than other students and his difficulties can be attributed to Fetal Alcohol Effects.

He is a cheerful child, well liked by all in the classroom and always strives to do his best. He has enjoyed problem solving activities because they allow him to come up with an incorrect solution and still learn something from it. He has also found out that he isn't the only one experiencing difficulties solving problems. Also he has enjoyed some success when he has been able to steer the solution in a particular direction when other students with more aptitude have had difficulties. Robbie is part of a small group of students who get additional help on a daily basis outside the classroom. To accommodate this group of students and because I do not wish them to miss out on the same thing each time, I rotate what is being taught during that time slot. One day a few months ago Robbie approached me as he was leaving the room and asked me if I would be doing problem solving while he was out. I told him no. He then told me he didn't want me to do problem solving while he was out of the room because he really likes it. He continued to ask me the same question every time he left the room until I promised him that I would never again do problem solving unless he was in the room! What better reward can a teacher get?

Parting Words

The best discoveries are the ones we make ourselves, no one can do it for us, but we can show the way--it's the journey that's important. Maybe this journey will encourage others to embark on their own voyage. The rewards are incredible.

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Appendix A: Some Interesting Web Sites

The following list does not attempt to be all inclusive, it merely shows the math sites which I visited and found interesting. They are not rated. By the time you read this many of these sites will have disappeared or relocated and new ones will be in existence. But they will lead you to other interesting sites.

<http://MathCentral.uregina.ca/> a K-12 Math Education Web Site developed and maintained by the Mathematics and Statistics Department and the faculty of Education at the University of Regina

<http://forum.swarthmore.edu/dr.math/> a site with many problems and links; click on Quick Reference to see the chart of what is available at this site; of particular interest is the problem of the week, plus the archives of previous problems of the week

<http://www.schoolnet.ca/home/e/>

<http://www.math.ucalgary.ca/~laf/colorful.html> a site offering research problems at an elementary level; of particular interest is the four colour problem

<http://csr.uvic.ca/~mmania/> a site which allows students to explore some topics in higher mathematics

<http://forum.swarthmore.edu/mathmagic/> through this site teams of students are paired up with other teams to engage in problem solving dialogues

<http://www.c3.lanl.gov/mega-math/> this site allows students to explore problems in higher mathematics; it is very teacher friendly and offers lesson plans on how to introduce and use these problems

<http://www.exemplars.com> this commercial site offers a rubric for problem solving and three problems (K-2, 3-5 and 6-8 levels) with benchmarks

<http://www.rhlschool.com/math.htm> this web site provides teachers with weekly problem worksheets for various levels

<http://www.eduplace.com/math/brain> a site offering a variety of problems

<http://www.cs.uidaho.edu/~casey931/conway/games.html> clever games for clever people; 16 games for all levels; they look deceptively simple; good for fostering critical thinking

<http://www.scholastic.com> a wealth of activities for all subject areas; also articles from the magazine Instructor

<http://www.srl.rmit.edu.au/mav/PSTC/problems> a site with problems and archives for all grade levels

<http://www.capecod.net/schrockguide/index.htm> Kathy Schrock's Guide for Educators; contains many links

<http://web66.coled.umn.edu> a site containing many links

<http://www.ericse.org>

<http://www.askeric.org>

Older students at our local high school were asked to search the Internet for interesting sites which could be used in our science unit on ***Animals.*** Some of these sites were then used as resources in teaching and learning about animals. This also allowed older students to practice their searching skills on the Internet.

<http://www.dolphinworld.org/research.htm>

<http://www.tmmc.org/> a site about marine mammals

<http://netvet.wustl.edu/e-zoo.htm> an electronic zoo offering many links to other sites

<http://www.acmepet.com/> a site about pets

<http://www.5tigers.org/> an excellent site about the five remaining subspecies of tigers

<http://web3.si.edu/organiza/museums/zoo/>

<http://pbs.org/kratts/world/>

<http://pbs.org/science/>

<http://www.wildpicture.com/> wildlife photography

<http://www.stevebloom.com/> wildlife photography

<http://spiders.arizona.edu/> a site about jumping spiders

<http://www.worldwildlife.org/tiger/>

<http://www.worldwildlife.org/whales/>

<http://www.nationalgeographic.com/kids/>

<http://www.nationalgeographic.com/solarsystem/>

<http://www.yellowstonepark.com>

<http://www.otternet.com/kids/>

<http://www.bluelion.org/>

<http://www.nationalgeographic.com/features/97/tigers/maina.html> an interactive site where students can create a habitat for a tiger

<http://www.dialspace.dial.pipex.com/agarman/>

<http://www.seaworld.org/>

<http://www.marinemultimedia.com/killerwhale/>

<http://www.sfzoo.com/>

Different kinds of sites exist:

- sites for teachers
  <http://MathCentral.uregina.ca/>
  <http://forum.swarthmore.edu/dr.math/>
  <http://www.schoolnet.ca/home/e/>
  <http://www.exemplars.com>
  <http://www.rhlschool.com/math.htm>
  <http://www.capecod.net/schrockguide/index.htm>
  <http://www.carolhurst.com/>

- sites for parents
  <http://www.ed.gov/pubs/parents/Math/>

- sites for students
  <http://MathCentral.uregina.ca/>
  <http://forum.swarthmore.edu/dr.math/>
  <http://www.csrice.edu/~sboone/Lessons/Titles/Pizza.html>
  <http://www.csun.edu/~vceed009/games.html> online board games

- sites which list sites related to a topic
  <http://www.capecod.net/schrockguide/index.htm>
  <http://web66.coled.umn.edu>
  <http://www.marshall-es.marshall.k12.tn.us/jobe/>
  <http://www.classroom.net>
  <http://www.nwrel/org/sky>
  <http://libits.library.ualberta.ca/library-html/libraries/coutts/lessons.html>
  <http://ofcn.org/cyber.serv/academy/ace/math/>

- sites developed by publishing firms
  <http://www.eduplace.com/math/brain>
  <http://www.scholastic.com>

- sites developed by teachers
  <http://www.capecod.net/schrockguide/index.htm>
  <http://users.uniserve.com/~g_games>

- sites developed by non-profit agencies
  <http://MathCentral.uregina.ca/>
  <http://www.stf.sk.ca/TMC/>
  <http://www.sasked.gov.sk.ca/>

- sites selling products
  <http://www.exemplars.com>

- sites developed by computer manufacturers
  <http://www.solutions.IBM.com/K12/teacher/>

- sites developed to help by answering teachers' and student's questions
  <http://MathCentral.uregina.ca/>
  <http://forum.swarthmore.edu/dr.math/>

- interactive sites
  <http://www.nationalgeographic.com/features/97/tigers/maina.html>

Appendix B: Handbook for Teachers: How to Use The Internet For Teaching and Learning

Out of a research project entitled *The Internet as a Teaching and Learning Tool*, done for the Dr. Stirling McDowell Foundation which focused on mathematical problem solving at the elementary level, there arose some items which can be generalized and be useful to other teachers in mathematics, as well as in other areas of study, at all grade levels.

Purpose

The purpose of this handbook is to help teachers who are not familiar with the Internet to make use of it for finding and using resources in their classrooms. It will not attempt to give step-by-step guidance on how to get to the Internet as there are many ways available and this would make the usefulness of this handbook limited. Other resources exist which offer this feature.

Teacher Constraints

Teachers are faced with increased expectations from the public. The challenges created by these expectations grow year by year. These challenges exist in all aspects of the teaching profession, including the use of the Internet. Therefore teachers may find it difficult to find the time to learn about the Internet and to spend some time navigating to find useful sites. Teachers find themselves at different levels of comfort in using the Internet, or even computers. Some school boards or school districts may be more supportive in terms of time or finances for teachers to learn about the Internet and how to link what is there with what is taught and learned in the classroom. Teachers have earned a reputation as being equal to any challenge presented to them. It is hoped this handbook will be of some help.

How the Internet can be used in the school setting

The use of the Internet can be viewed from different perspectives:

- ensuring that students become computer literate;
- supporting and enriching the curriculum;
- as a medium for interaction between teachers and learners, between learners and between teachers;
- as a tutor, rather than a tool;
- as a tool, rather than a tutor;
- offering support for individual learning;
- offering support for group learning;
- as an instructional management tool;
- as a means of communication;
- as a tool in administration;
- as a tool for professional development;
- for projects;
- for publishing;
- for learning exploration;
- as a research tool for students and teachers.

It is up to each teacher to decide how the Internet will be used in his or her classroom. For the purposes of the research project which generated this handbook I chose to use the Internet as a tool to support and enrich the grade three mathematics curriculum as it relates to problem solving. As I become more confident in using the Internet I will start looking at other ways I can use it for teaching and learning in my classroom.

How to Get to the Internet

Access to the Internet can vary from computer to computer depending on the software available and the services used to access the Internet.

- Find someone (a friend, a colleague, etc.) who can show you how to go from logging on the computer to gaining access to the Internet;
- buy a notebook and write this information down.

***** Suggestion Number 1 ****

Do not be afraid to click the mouse or touch the keys. There is very little damage you can do. The worst that can happen is that you will lose your place, lose your information or freeze up the machine.

What You Need to Know Once You Are There

On your screen you will see a pull-down menu at the top and a row of buttons below the menu. The absolute minimum items you need to become familiar with to navigate are the following:

- Bookmarks: this is where you go to bookmark a site you find very interesting and would like to return to in the future. It is also where you go to retrieve a bookmark previously placed there.
- Back button: clicking on this button will always take you back to the previous page you visited.
- Search button: clicking on this button will take you to a search engine where you will type in key words for a search. For example, I typed in <mathematics>, <problem solving>, <elementary> to find sites related to mathematical problem solving for my grade three classroom. The first ten to twenty sites listed are the most likely to take you where you want to go, but there will be many which are useless. If too many are useless, start a new search but try and narrow the area you are looking for.
- Print button: this will allow you to print what is at this particular location; it will not save it for you. A note of caution: please check, by scrolling on the right side of the window, how long the document which you want to print is.
- Location: this is the area where you can type in a web address which you know.
- The mouse moves your cursor on the page: at times it appears as an arrow. Other times it appears as a hand: this means that if you click on this area, you will be taken to another web site or another part of the web site; it links you to another place. Once you have clicked, the cursor will look like an hourglass: this means it is taking you to this other place.

***** Suggestion Number 2 ****

Do not be afraid to click on the pull-down menu to investigate what is there. It's like walking through a show home, you peek into different rooms and you can always get back to where you were.

How to Find Things

- Do a search.
- Go to one of the sites cited in this handbook, you will then find many links to other sites.
- Professional journals and colleagues often point teachers to interesting web sites.

You only need to find one or two good sites to make good use of the Internet. Don't worry that you haven't found all the relevant sites or the best site for your topic. The Internet is not set up like a library. It really does resemble a web. Many of the sites related to a certain topic are actively linked; therefore, once you have found a site, you have easy access to others that are similar.

** Suggestion Number 3 **

Bookmark all interesting sites you find!

** Suggestion Number 4 **

There is usually more than one way to do anything on the computer or the Internet. Don't worry about being efficient; as you become more familiar with the system you will find your own shortcuts.

** Suggestion Number 5 **

You don't have to be an expert in the first year or even the first 10 years.

What to Do Once You Have Found Things

- Bookmark them.
- Print them.
- Save them under <file> if you wish to adapt them.
- Always reference them when you use them.
- Make sure they are related to curriculum objectives.
- Adapt them to suit the needs of your students if necessary.
- Make sure they are not biased (gender, race, ability).
- Evaluate them: Is the language appropriate for my students? Is there enough detail, or too much? Is the web site a reliable one? Is the information accurate? Will this challenge my students to think and be creative? Does this present something which may not be available through another medium or is it just more of the same?
- After the students have used it: Was it easy for the students to use? Was it interesting for them? Did it accomplish what it was supposed to? Would you use it again? How would you use it again? Is it easy to assess how my students did? Did this provide the students with a new way of accessing information or learning? Could the objectives have been met just as well or better without this resource?

Sites, Sites, Sites!

Different kinds of sites exist:

- sites for teachers
  <http://MathCentral.uregina.ca/>
  <http://forum.swarthmore.edu/dr.math/>
  <http://www.schoolnet.ca/home/e/>
  <http://www.exemplars.com>
  <http://www.rhlschool.com/math.htm>
  <http://www.capecod.net/schrockguide/index.htm>
  <http://www.carolhurst.com/>

- sites for parents
  <http://www.ed.gov/pubs/parents/Math/>

- sites for students
  <http://MathCentral.uregina.ca/>
  <http://forum.swarthmore.edu/dr.math/>
  <http://www.csrice.edu/~sboone/Lessons/Titles/Pizza.html>
  <http://www.csun.edu/~vceed009/games.html> online board games

- sites which list sites related to a topic
  <http://www.capecod.net/schrockguide/index.htm>
  <http://web66.coled.umn.edu>
  <http://www.marshall-es.marshall.k12.tn.us/jobe/>
  <http://www.classroom.net>
  <http://www.nwrel/org/sky>
  <http://libits.library.ualberta.ca/library-html/libraries/coutts/lessons.html>
  <http://ofcn.org/cyber.serv/academy/ace/math/>

- sites developed by publishing firms
  <http://www.eduplace.com/math/brain>
  <http://www.scholastic.com>

- sites developed by teachers
  <http://www.capecod.net/schrockguide/index.htm>
  <http://users.uniserve.com/~g_games>

- sites developed by non-profit agencies
  <http://MathCentral.uregina.ca/>
  <http://www.stf.sk.ca/TMC/>
  <http://www.sasked.gov.sk.ca/>

- sites selling products
  <http://www.exemplars.com>

- sites developed by computer manufacturers
  <http://www.solutions.IBM.com/K12/teacher/>

- sites developed to help by answering teachers' and student's questions
  <http://MathCentral.uregina.ca/>
  <http://forum.swarthmore.edu/dr.math/>

- interactive sites
  <http://www.nationalgeographic.com/features/97/tigers/maina.html>

The following list does not attempt to be all inclusive, it merely shows the math sites which I visited and found interesting. They are not rated. By the time you read this many of these sites will have disappeared or relocated and new ones will be in existence. But they will lead you to other interesting sites.

<http://MathCentral.uregina.ca/> a K-12 Math Education Web Site developed and maintained by the Mathematics and Statistics Department and the faculty of Education at the University of Regina

<http://forum.swarthmore.edu/dr.math/> a site with many problems and links; click on Quick Reference to see the chart of what is available at this site; of particular interest is the problem of the week, plus the archives of previous problems of the week

<http://www.schoolnet.ca/home/e/>

<http://www.math.ucalgary.ca/~laf/colorful.html> a site offering research problems at an elementary level; of particular interest is the four colour problem

<http://csr.uvic.ca/~mmania/> a site which allows students to explore some topics in higher mathematics

<http://forum.swarthmore.edu/mathmagic/> through this site teams of students are paired up with other teams to engage in problem solving dialogues

<http://www.c3.lanl.gov/mega-math/> this site allows students to explore problems in higher mathematics; it is very teacher friendly and offers lesson plans on how to introduce and use these problems

<http://www.exemplars.com> this commercial site offers a rubric for problem solving and three problems (K-2, 3-5 and 6-8 levels) with benchmarks

<http://www.rhlschool.com/math.htm> this web site provides teachers with weekly problem worksheets for various levels

<http://www.eduplace.com/math/brain> a site offering a variety of problems

<http://www.cs.uidaho.edu/~casey931/conway/games.html> clever games for clever people; 16 games for all levels; they look deceptively simple; good for fostering critical thinking

<http://www.scholastic.com> a wealth of activities for all subject areas; also articles from the magazine Instructor

<http://www.srl.rmit.edu.au/mav/PSTC/problems> a site with problems and archives for all grade levels

<http://www.capecod.net/schrockguide/index.htm> Kathy Schrock's Guide for Educators; contains many links

<http://web66.coled.umn.edu> a site containing many links

<http://www.ericse.org>

<http://www.askeric.org>

Older students at our local high school were asked to search the Internet for interesting sites which could be used in our science unit on *Animals.* Some of these sites were then used as resources in teaching and learning about animals. This also allowed older students to practice their searching skills on the Internet.

<http://www.dolphinworld.org/research.htm>

<http://www.tmmc.org/> a site about marine mammals

<http://netvet.wustl.edu/e-zoo.htm> an electronic zoo offering many links to other sites

<http://www.acmepet.com/> a site about pets

<http://www.5tigers.org/> an excellent site about the five remaining subspecies of tigers

<http://web3.si.edu/organiza/museums/zoo/>

<http://pbs.org/kratts/world/>

<http://pbs.org/science/>

<http://www.wildpicture.com/> wildlife photography

<http://www.stevebloom.com/> wildlife photography

<http://spiders.arizona.edu/> a site about jumping spiders

<http://www.worldwildlife.org/tiger/>

<http://www.worldwildlife.org/whales/>

<http://www.nationalgeographic.com/kids/>

<http://www.nationalgeographic.com/solarsystem/>

<http://www.yellowstonepark.com>

<http://www.otternet.com/kids/>

<http://www.bluelion.org/>

<http://www.nationalgeographic.com/features/97/tigers/maina.html> an interactive site where students can create a habitat for a tiger

<http://www.dialspace.dial.pipex.com/agarman/>

<http://www.seaworld.org/>

<http://www.marinemultimedia.com/killerwhale/>

<http://www.sfzoo.com/>

Appendix C: Manuel pour l'enseignant/e: Comment utiliser l'Internet pour l'enseignement et l'apprentissage

Les notes et suggestions suivantes proviennent d'un projet de recherche entrepris sous les auspices de la Fondation Dr. Stirling Mc Dowell intitulé *The Internet as a Teaching and Learning Tool*. Bien que ce projet mis l'emphase sur la résolution de problèmes mathématiques au niveau élémentaire, les notes et suggestions peuvent être généralisées afin d'être utiles à tous les enseignants et enseignantes.

But

Le but de ce manuel est d'aider les enseignants et enseignantes à se familiariser avec l'Internet afin de trouver et utiliser de ses ressources dans leurs salles de classe. Ce manuel n'est pas un guide, étape par étape, pour se rendre à l'Internet puisqu'il existe diverses façons de s'y rendre. D'autres ressources offrent cette information.

Contraintes

Les attentes du public, face au travail des enseignants et enseignantes, augmentent sans cesse. Les défis créés par ces attentes augmentent d'année en année. Ces défis existent dans tous les domaines de l'enseignement, y compris l'utilisation de l'Internet. Donc, les enseignants et enseignantes peuvent difficilement trouver le temps nécessaire pour apprendre à utiliser l'Internet ainsi qu'à y trouver des sites utiles. Les enseignants et enseignantes ne se sentent pas tous confortables quand vient le temps d'utiliser l'Internet, et même les ordinateurs en général. Certaines commissions scolaires offrent plus de support que d'autres, au niveau de temps et argent pour que les enseignants et enseignantes puissent se familiariser avec l'Internet et faire des liens avec ce qui se passe dans la salle de classe. Les enseignants et enseignantes ont la réputation, bien méritée d'ailleurs, de pouvoir accepter les défis qui se présentent dans leur vie professionnelle. Il est à espérer que ce manuel rendra la tâche un peu plus facile.

L'utilisation de l'Internet dans les écoles

On peut envisager l'utilisation de l'Internet sous différentes perspectives:

- pour s'assurer que les élèves se familiarisent avec les ordinateurs;
- pour supporter et enrichir les programmes d'études;
- comme médium d'interaction entre les enseignants et enseignantes et les élèves;
- comme tuteur, plutôt qu'outil;
- comme outil, plutôt que tuteur;
- pour supporter l'apprentissage autonome;
- pour supporter l'apprentissage en groupe;
- comme outil pour gérer l'enseignement;
- comme moyen de communication;
- comme outil d'administration;
- comme outil de développement professionnel;
- pour faire des projets;
- pour publier;
- pour explorer;
- comme outil de recherche pour le corps enseignant et les élèves.

Chaque enseignant ou enseignante doit décider comment utiliser l'Internet dans sa salle de classe. Dans le rapport qui a généré ce manuel, j'ai choisi d'utiliser l'Internet comme outil pour supporter et enrichir le programme de mathématiques de troisième année, par rapport à la résolution de problèmes. Au fur et à mesure que j'aurai plus de confiance à utiliser l'Internet, je pourrai ajouter d'autres façons d'utiliser l'Internet dans ma salle de classe.

Comment se rendre à l'Internet

L'accès à l'Internet varie pour chaque ordinateur dépendant du logiciel et des services utilisés pour s'y rendre.

- Trouver quelqu'un (ami, collègue, etc.) qui s'y connaît pour montrer comment se rendre à l'Internet;
- acheter un petit cahier de notes et noter toute l'information que cette personne vous donne.

***** Suggestion 1 *****

On ne doit pas craindre d'activer la souris ou de toucher les clés du clavier. Il y a très peu de dommage qui peut se faire. Le pire est que l'on perd sa place, perd son information ou que l'ordinateur "gèle".

Ce qu'il faut connaître lorsqu'on y arrive

Au haut de l'écran se trouve un menu que l'on peut descendre et sous ce menu se trouve une rangée de boutons. Le nombre minimum de commandes que l'on doit connaître pour naviguer sont les suivantes:

- *Bookmarks*: c'est l'endroit où l'on va pour mettre un signet quand on trouve un site particulièrement intéressant et l'on voudrait y retourner plus tard. C'est aussi l'endroit où l'on va lorsqu'on veut retourner à ce site intéressant.
- Le bouton *Back*: lorsqu'on touche ce bouton on retourne à la page précédente.
- Le bouton *Search*: lorsqu'on touche ce bouton on se retrouve à un engin de recherche où on introduit les mots-clé qui nous aideront à trouver l'information que l'on recherche. Par exemple, j'ai introduis les mots <mathematics>, <problem solving>, <elementary> pour trouver des sites se rapportant à la résolution de problèmes mathématiques pour la troisième année. Les premiers dix ou vingt sites mentionnés sont typiquement ceux qui sont les plus utiles, bien que certains d'entre eux seront probablement inutiles. Si trop de sites sont inutiles, recommencer la recherche, utilisant des mots qui pourraient éliminer ces sites.
- Le bouton *Print*: ce bouton permet d'imprimer ce qui se trouve à cette location; rien ne sera sauvegarder. Il est nécessaire de vérifier, en activant les flèches à droite de l'écran, la longueur du document avant de l'imprimer.
- *Location*: c'est l'endroit où l'on peut écrire l'adresse d'un site que l'on veut visiter.
- La souris bouge le curseur sur l'écran: parfois le curseur apparaît comme une flèche. D'autres fois, le curseur apparaît comme une main: ceci indique que cette section est reliée à un autre site ou à une autre partie du site. Quand la main est activée, le curseur ressemble à un sablier jusqu'à ce que le transfert soit fait.

***** Suggestion 2 *****

On ne doit pas craindre d'explorer le menu. C'est un peu comme se promener dans une maison modèle: on peut aller dans n'importe quelle pièce, mais on peut toujours retourner à notre point de départ.

Comment trouver des sites

- Faire une recherche en utilisant le bouton *Search*.
- Se rendre à un des sites mentionnés dans ce manuel, on peut y trouver beaucoup de liens à d'autres sites.
- Les revues professionnelles, ainsi que les collègues, peuvent nous introduire à des sites intéressants.

Il est nécessaire de trouver seulement un ou deux bons sites pour utiliser l'Internet de façon efficace. On ne doit pas s'inquiéter si on ne trouve pas tous les sites reliés au sujet que l'on recherche. L'Internet ne fonctionne pas comme une bibliothèque, mais plutôt comme une toile d'araignée. La plupart des sites ayant les mêmes intérêts ont des liens actifs (on peut se rendre à un autre site immédiatement); donc, lorsqu'on trouve un site utile, cela nous donne accès à d'autres sites semblables.

***** Suggestion 3 *****

Mettre un signet à tous les sites intéressants!

***** Suggestion 4 *****

Habituellement, il y a plus d'une façon de faire chaque chose à l'ordinateur ou sur l'Internet. On ne doit pas s'occuper de faire les choses le plus efficacement possible; avec la familiarité au système on trouve ses propres raccourcis.

***** Suggestion 5 ****

Ce n'est pas important de devenir expert.

Que faire lorsqu'on trouve des choses intéressantes

- Mettre un signet.
- Les imprimer.
- Les sauvegarder sous <file> pour, à la suite, les adapter.
- Faire référence à ces sites lorsqu'on les utilise.
- S'assurer qu'ils sont reliés aux objectifs des programmes d'études.
- Les adapter aux besoins des élèves si nécessaire.
- S'assurer qu'ils ne renforcent pas les préjudices et les stéréotypes.
- Les évaluer: Le niveau de langue est-il approprié aux élèves? Y a-t-il assez de détails, ou y en a-t-il trop? Le site est-il fiable? Est-ce que l'information est correcte? Mes élèves seront-ils mis au défi? Devront-ils utiliser la pensée logique ou être créatif? Est-ce que l'information présentée est disponible ailleurs ou non?
- A la suite: Est-ce que les élèves ont eu des difficultés à utiliser le site ou l'information? Est-ce qu'ils ont trouvé cela intéressant? L'objectif a-t-il été atteint? Est-ce qu'on l'utiliserait à nouveau? Comment l'utiliserait-on la prochaine fois? Est-ce facile évaluer les élèves? Est-ce que les connaissances ou la démarche étaient nouvelles? Les objectifs auraient-ils pu être atteints aussi bien ou mieux sans cette ressource?

Sites, Sites, Sites!

Il existe différents types de sites:

- des sites pour les enseignants et enseignantes
  <http://MathCentral.uregina.ca/>

<http://forum.swarthmore.edu/dr.math/>
<http://www.schoolnet.ca/home/e/>
<http://www.exemplars.com>
<http://www.rhlschool.com/math.htm>
<http://www.capecod.net/schrockguide/index.htm>
<http://www.carolhurst.com/>

- des sites pour les parents
  <http://www.ed.gov/pubs/parents/Math/>

- des sites pour les élèves
  <http://MathCentral.uregina.ca/>
  <http://forum.swarthmore.edu/dr.math/>
  <http://www.csrice.edu/~sboone/Lessons/Titles/Pizza.html>
  <http://www.csun.edu/~vceed009/games.html> online board games

- des sites qui nomment d'autres sites reliés à un sujet
  <http://www.capecod.net/schrockguide/index.htm>
  <http://web66.coled.umn.edu>
  <http://www.marshall-es.marshall.k12.tn.us/jobe/>
  <http://www.classroom.net>
  <http://www.nwrel/org/sky>
  <http://libits.library.ualberta.ca/library-html/libraries/coutts/lessons.html>
  <http://ofcn.org/cyber.serv/academy/ace/math/>

- des sites développés par des maisons d'édition
  <http://www.eduplace.com/math/brain>
  <http://www.scholastic.com>

- des sites développés par des enseignants et enseignantes
  <http://www.capecod.net/schrockguide/index.htm>
  <http://users.uniserve.com/~g_games>

- des sites développés par des agences non-profit
  <http://MathCentral.uregina.ca/>
  <http://www.stf.sk.ca/TMC/>
  <http://www.sasked.gov.sk.ca/>

- des sites vendant des produits
  <http://www.exemplars.com>

- des sites développés par des manufacturiers d'ordinateurs
  <http://www.solutions.IBM.com/K12/teacher/>

- des sites développés pour répondre aux questions des enseignants et des élèves
  <http://MathCentral.uregina.ca/>
  <http://forum.swarthmore.edu/dr.math/>

- des sites interactifs
  <http://www.nationalgeographic.com/features/97/tigers/maina.html>

La liste qui suit ne prétend pas contenir tous les sites reliés à la résolution de problèmes mathématiques pour le niveau élémentaire; elle contient seulement les sites que j'ai visité et trouvé utiles et intéressants. Ils n'ont pas été évalués. Il est très probable que certains de ces sites auront disparus ou se trouveront à une nouvelle adresse, mais aussi de nouveaux sites seront en existence. Chacun de ces sites pourra vous conduire à de nouveaux sites.

<http://MathCentral.uregina.ca/> un site développé pour les mathématiques de la maternelle à la douzième année; ce site est maintenu par le département de mathématiques et statistiques et la faculté d'éducation à l'université de Regina

<http://forum.swarthmore.edu/dr.math/> un site contenant beaucoup de problèmes et de liens; activer Quick Reference pour voir ce qui est disponible à ce site; d'intérêt, il y a le problème de la semaine, de même que les archives pour les problèmes de la semaine

<http://www.schoolnet.ca/home/e/>

<http://www.math.ucalgary.ca/~laf/colorful.html> un site offrant des problèmes de recherche à un niveau élémentaire, en particulier le problème des quatre couleurs

<http://csr.uvic.ca/~mmania/> un site permettant aux élèves d'explorer des sujets de hautes mathématiques

<http://forum.swarthmore.edu/mathmagic/> par l'entremise de ce site des équipes d'élèves travaillent avec d'autres équipes pour résoudre des problèmes et en discuter

<http://www.c3.lanl.gov/mega-math/> ce site permet aux élèves d'explorer des sujets de hautes mathématiques; offre des plans de leçons pour introduire et utiliser ces problèmes

<http://www.exemplars.com> un site commercial offrant un modèle d'évaluation pour la résolution de problèmes ainsi que trois problèmes

<http://www.rhlschool.com/math.htm> ce site offre aux enseignants et enseignantes des problèmes hebdomadaires pour divers niveaux

<http://www.eduplace.com/math/brain> un site offrant une variété de problèmes

<http://www.cs.uidaho.edu/~casey931/conway/games.html> seize jeux pour divers niveaux; ils ont l'air simple mais metteront les élèves au défi et développeront leur pensée critique

<http://www.scholastic.com> une variété d'activités pour tous les sujets; contient aussi des articles de la revue *Instructor*

<http://www.srl.rmit.edu.au/mav/PSTC/problems> un site avec des problèmes et des archives pour tous les niveaux

<http://www.capecod.net/schrockguide/index.htm> Kathy Schrock's Guide for Educators; contient beaucoup de liens

<http://web66.coled.umn.edu> un site contenant beaucoup de liens

<http://www.ericse.org>

<http://www.askeric.org>

Des élèves de notre école secondaire locale ont entrepris de faire une recherche sur l'Internet pour des sites intéressants que l'on pourrait utiliser dans une unité sur ***Les Animaux***. Certains de ces sites ont par la suite servis de ressources pour cette unité. Les élèves du secondaire ont ainsi pu développer leurs habiletés à faire des recherches sur l'Internet.

<http://www.dolphinworld.org/research.htm>

<http://www.tmmc.org/> un site reliés aux mammifères marins

<http://netvet.wustl.edu/e-zoo.htm> un zoo électronique offrant beaucoup de liens à d'autres sites

<http://www.acmepet.com/> un site relié aux animaux familiers

<http://www.5tigers.org/> un site excellent relié aux cinq sous-espèces de tigres

<http://web3.si.edu/organiza/museums/zoo/>

<http://pbs.org/kratts/world/>

<http://pbs.org/science/>

<http://www.wildpicture.com/>

<http://www.stevebloom.com/>

<http://spiders.arizona.edu/>

<http://www.worldwildlife.org/tiger/>

<http://www.worldwildlife.org/whales/>

<http://www.nationalgeographic.com/kids/>

<http://www.nationalgeographic.com/solarsystem/>

<http://www.yellowstonepark.com>

<http://www.otternet.com/kids/>

<http://www.bluelion.org/>

<http://www.nationalgeographic.com/features/97/tigers/maina.html> un site interactif où les élèves peuvent créer un habitat pour un tigre

<http://www.dialspace.dial.pipex.com/agarman/>

<http://www.seaworld.org/>

<http://www.marinemultimedia.com/killerwhale/>

<http://www.sfzoo.com/>