Prime Minister's Awards for Teaching Excellence

EXEMPLARY PRACTICES

1997 Recipients

Canada

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Prime Minister's Awards for Teaching Excellence

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1997 RECIPIENTS

PRIME MINISTER • PREMIER MINISTRE

As Prime Minister of Canada, I meet people of influence every day, but rarely do I have the opportunity to meet a group of people who have such a significant influence on our youth. I had that chance at the fifth national awards ceremony in honour of the 1997 Certificate of Excellence winners of the Prime Minister's Awards for Teaching Excellence. Teachers play an extremely important role in preparing young people and, therefore, Canada for future success, and I am excited to be personally involved in this program.

With the help of our corporate partners, the Prime Minister's Awards honour teachers who have best prepared students for the challenges of a changing society and knowledge-based economy. The achievements of all recipients are celebrated in their schools and home communities. Certificate of Excellence recipients also come to Ottawa to celebrate their achievements at an awards ceremony, visit sites of interest to educators, and exchange best practices for the benefit of themselves and other Canadian teachers. This *Exemplary Practices* publication is an educator's resource. It consists of award-winning ideas that 1997 recipients shared with each other during their time in Ottawa.

You may be able to utilize some of these ideas in your own classroom. Perhaps they will sow the seeds for even more innovative, exciting projects.

I extend my sincere congratulations, once again, to all of the 1997 recipients of the Prime Minister's Awards for Teaching Excellence for their professional dedication and success. Thank you for your contribution to Canada.

Ottawa

1998

GREETINGS FROM THE 1997 CERTIFICATE OF EXCELLENCE RECIPIENTS

This was the first year the Prime Minister's Awards competition was open to teachers from all disciplines. As a result, there was an incredible collection of ideas on the table when we got together for the first time. We had quite a discussion about our work, and some of us are still talking months later. It would not be honest to say we all agreed about everything but there were many common elements in our teaching practices.

We found, for example, that we are all trying to raise the bar. Every Certificate of Excellence recipient this year and in previous years was obviously trying to find more effective ways to help students learn. Approaches that were new and exciting just a few years ago are often much more advanced than when we first heard about them.

At the same time, we learned that while no one has found the perfect approach, successful teachers are all good at creating relevant and structured environments in which their students can learn. What environments are best? That is a question we don't know the answer to, but we do all have educated opinions and, in this book, we share some of the things we have learned about learning environments.

All of the ideas you will find here have worked for us and we share them with other teachers in the hope that they can use them in their classrooms. Better yet, if you have great ideas of your own, we encourage you to prove them in the classroom and then tell others about them.

There are many avenues open to Canadian teachers looking to share ideas. The Internet has made this communication easier and faster than ever before, allowing us to connect with colleagues locally and around the world. We encourage you to visit the Prime Minister's Awards Web site (**http://www.schoolnet.ca**) where you will find lots of ideas and information, including electronic versions of several editions of this book and links to other useful Web sites.

Award recipients come from all parts of Canada. Due to space limitations, only Certificate of Excellence recipients are profiled here. However, all Certificate of Achievement recipients are listed, along with their schools and communities, in the back of this book. Maybe you will be inspired to contact a teacher near you. If you would like more information, please call 1-800-268-6608 or send an E-mail (**pmawards@ic.gc.ca**).

About the Prime Minister's Awards for Teaching Excellence

The Prime Minister's Awards for Teaching Excellence recognize the efforts of outstanding teachers in all disciplines who provide students with the tools to become good citizens, to grow and prosper as individuals, and to contribute to Canada's growth, prosperity and well-being.

The education stakeholders from across Canada who make up the national and regional selection committees look for evidence that teachers have achieved outstanding results with students, inspired them to learn and continue learning, and equipped them with the skills and attitudes they need to succeed in our changing society and knowledge-based economy. Specifically, they recognize nominees who have excelled in some or all of the following areas:

- exemplary teaching practices
- student interest and participation
- student achievement/performance
- student skills development
- teacher commitment and leadership.

Teachers are eligible for two awards: the Certificate of Excellence and the Certificate of Achievement. All recipients receive a certificate and pin along with a letter from the Prime Minister. Recipients' schools receive cash awards to be used for educational purposes, such as professional development or equipment, and a certificate recognizing their support and contribution to the teachers' achievements.

Fifteen Certificate of Excellence recipients travel to Ottawa for five days of tours, best practice sessions and a ceremony with the Prime Minister where they receive their award certificate. Cabinet ministers or members of Parliament are invited to participate in local events to honour Certificate of Achievement recipients in their communities.

For more information about the program, call our hotline (1-800-268-6608), E-mail us (**pmawards@ic.gc.ca**) or visit our Web page (**http://www.schoolnet.ca**).

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PRIME MINISTER'S AWARDS CORPORATE PARTNERS

Ensuring that Canadian youth have the education and skills required to become good citizens, and to succeed in a changing society and knowledge-based economy, is an issue that concerns us all. Increasingly, Canada's corporate sector has helped meet that challenge by providing scholarships and co-op placements for students, sponsoring academic awards and contests, providing professional development opportunities and internships for teachers, taking part in business/education partnerships, and enabling employees to serve as resource people for schools.

Industry Canada is pleased to be working with four corporate partners of the Prime Minister's Awards for Teaching Excellence. All of these corporations have demonstrated a strong commitment to education. Their support will enable this program to honour hundreds of outstanding Canadian teachers and to share their winning ideas and teaching methods throughout the country.

Bell Canada supports many education-related initiatives, including SchoolNet, Expo Science, the Chemistry and Physics Olympiad, the National History Awards, and the Youth Science Foundation. To assist teachers in the classroom, Bell recently distributed more than 8700 free copies of a CD-ROM about Alexander Graham Bell to schools in Ontario and Quebec, and supported the 1996 *Canada Remembers* education resource kit. Bell also invests more than $3 million per year to support research at universities in Ontario and Quebec.

GE Canada sponsors, and is involved with, several educational initiatives, including the E.C. Drury School for the Deaf and the Canada Scholarships Program. Several hundred GE Canada employees volunteer their time to projects, from working with disabled children to mentoring and participating in special education programs. Additional sponsorships are also awarded by GE Canada to many Canadian universities, colleges and teaching hospitals.

Over the years, **Kraft Canada** has supported many national programs to recognize teachers and foster better education, including the McLuhan Foundation for Teaching Excellence, the KidsWorld Teacher of the Year Award, Take Our Kids to Work and Junior Achievement. Kraft Canada is a major sponsor of *Protect our Planet*, a national publication tailored to grade school students and distributed to schools across the country. Kraft has also developed alliances to promote the link between nutrition and learning.

The **Royal Bank Financial Group** has made grants in excess of $44 million since 1979 covering a wide variety of educational organizations, including the Queen's University National Teaching Fellowship in Education and the Conference Board of Canada/Royal Bank National Partners in Education Awards. The Queen's Fellowship has included a special program to bring Prime Minister's Award recipients in science, mathematics and technology to the Faculty of Education to share their expertise with teachers in training.

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OUTSTANDING IN THE FIELD

Field trips used to have an image problem. Students saw them primarily as reprieves from regular assignments, and other teachers resented having students pulled out of their classes. Often, students' most significant memories of these trips concerned who threw up on the bus.

In recent years, the humble field trip has had a makeover thanks to dedicated teachers who recognize great opportunities for learning outside the classroom. In this section, three of these teachers pass along some of their ideas for making field trips into real-life learning experiences. **John Dupuis** and **Cal Kullman** tell readers how they create adventures that fit into the existing curriculum. In a more radical approach, **Robert Sharp** tells us how he redesigned curriculum delivery around in-depth field studies.

TAKE ME TO THE RIVER...

JOHN DUPUIS
BISHOP PINKHAM
JUNIOR HIGH SCHOOL
CALGARY, ALBERTA

CAL KULLMAN
LOUIS RIEL SCHOOL
CALGARY, ALBERTA

John Dupuis of Bishop Pinkham Junior High School and Cal Kullman of Louis Riel School in Calgary are two outstanding science and environmental education teachers. They both have science degrees and extensive experience in summer field work, and have taught for the Calgary Board of Education at the junior high school level (grades 7 through 9) — Mr. Dupuis for seven years and Mr. Kullman for 15.

Teaching science and environmental awareness allows them to combine their appreciation of outdoor activity and the natural environment with their enjoyment of working with young people. They share an impressive list of accomplishments in their work with students. Among their projects are hundreds of field trips, an in-school climbing wall, a mobile cross-country ski program and summer science camps.

The River Watch Science Program is their most successful project to date. Originally based in Calgary, the program now runs on eight Alberta rivers with nearly 4000 students annually. A River Watch Web site (**http://www.cadvision.com/beybooks/river**) reports on developments and findings of the program. The popularity of their programs demonstrates the talent, commitment and leadership of Mr. Dupuis and Mr. Kullman.

John Dupuis and Cal Kullman recognize the special appeal and unique learning potential of school field trips. At the same time, they understand that a successful field trip does not just happen. They know that carefully detailed planning that includes the needs of teachers and students, an awareness of both the potential and the limitations of the field environment, and a clearly defined curriculum objective and pilot program to develop and refine the trip are necessary ingredients in the design of a field trip.

Mr. Dupuis and Mr. Kullman have developed a procedure to create successful and memorable field trips for junior high school science students. After running these trips with their classes, they share their expertise with students and teachers from other schools in Alberta by creating a complete field trip package of classroom materials, necessary equipment, suggested route and schedule of activities.

DESIGN A FIELD TRIP THAT DOVETAILS WITH THE CURRICULUM

Through our experience in a number of teaching environments in and out of the school system, we believe that experiential learning is one of our most powerful teaching styles. Experiential education centres on providing real-world, hands-on experiences and adventures that engage students. If we teach in the context of an environmental or science topic, the students see it first hand, and they then have a better grasp of the concept and appreciate how it affects them.

Our students range from grades 7 through 11, from 12- to 17-years-old. Kids tend to be very social and self-centred at this age, yet they respond well to idealism and grand causes. They enjoy physical challenges and learn best from concrete experiences. A field trip is a great way to combine the need for peer interaction, physical activity and fun in this age group while encouraging safety, scientific testing procedures and environmental awareness.

We design our field trips to be adventures wrapped around science. When parents or friends ask students what they are going to be doing on the trip,

they inevitably say, "Oh, we're going rafting on the river." Only later do they remember that they are also going to be conducting water quality tests. The adventure gets their interest focussed and their minds ready to learn the science.

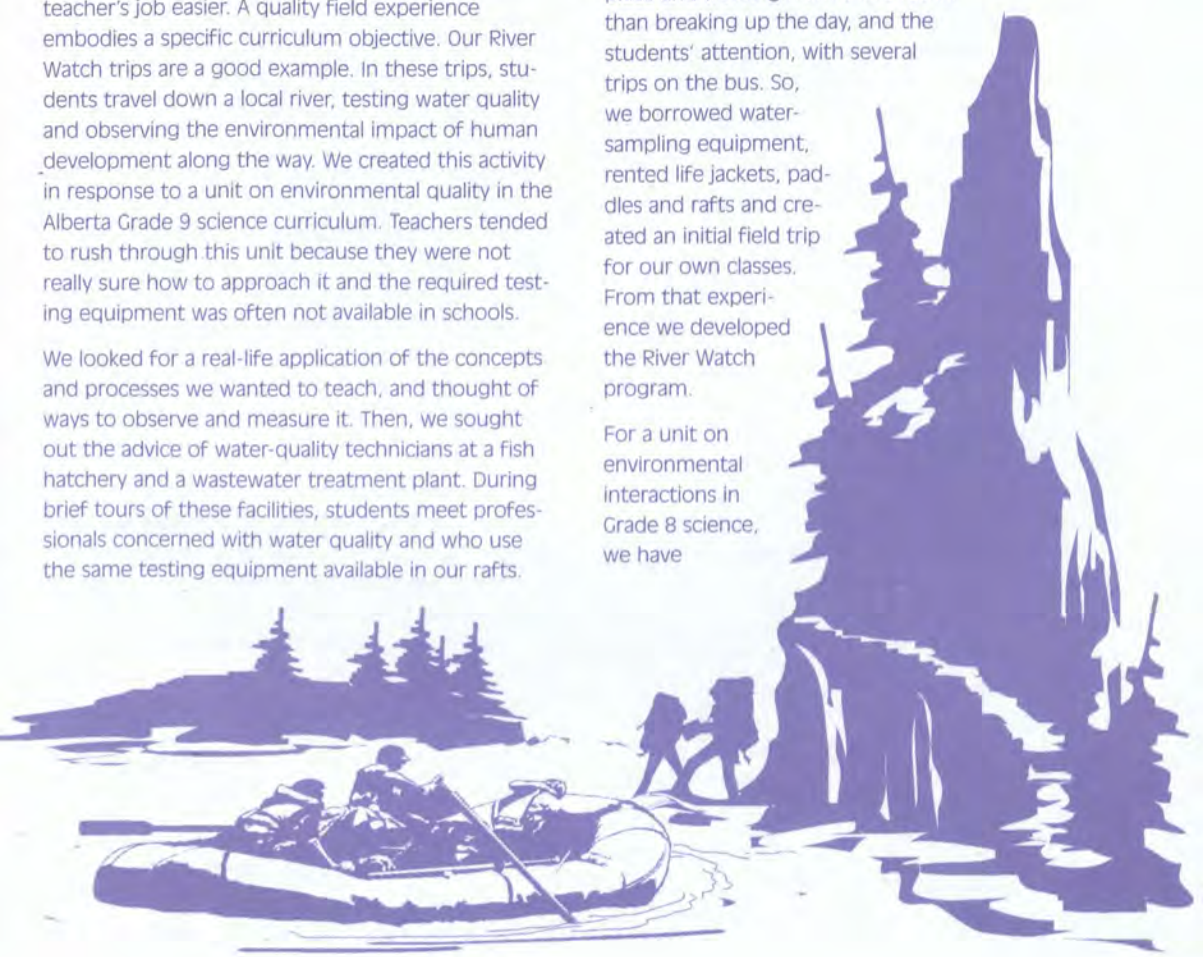
All through the process of developing a curriculum-based field trip package, we use the experience of our own classes to experiment, reassess and refine the trip's effectiveness before we share it with other teachers. We always keep in mind the needs of our two "clients" — the teachers and the students.

One focus of the field trip design process is to dovetail with current core curriculum and make a teacher's job easier. A quality field experience embodies a specific curriculum objective. Our River Watch trips are a good example. In these trips, students travel down a local river, testing water quality and observing the environmental impact of human development along the way. We created this activity in response to a unit on environmental quality in the Alberta Grade 9 science curriculum. Teachers tended to rush through this unit because they were not really sure how to approach it and the required testing equipment was often not available in schools.

We looked for a real-life application of the concepts and processes we wanted to teach, and thought of ways to observe and measure it. Then, we sought out the advice of water-quality technicians at a fish hatchery and a wastewater treatment plant. During brief tours of these facilities, students meet professionals concerned with water quality and who use the same testing equipment available in our rafts. Students feel that they are involved in "real science" and that their data collection will be valued and useful. Consequently, they make a real effort to conduct careful observations and become self-directed technicians at subsequent sampling sites.

Our second design focus is to capture the students' attention with a continuous, consistent experience. For the water-quality unit, we could have simply set up a bus trip to several sites along the river. But travelling down the river on rafts gives students a better sense of what the river is like, gives them an important component of physical activity, and makes it fun. As much as possible, we plan on going to one place and working from there rather than breaking up the day, and the students' attention, with several trips on the bus. So, we borrowed water-sampling equipment, rented life jackets, paddles and rafts and created an initial field trip for our own classes. From that experience we developed the River Watch program.

For a unit on environmental interactions in Grade 8 science, we have



designed a field trip called Wildlife Watch, combining snowshoeing and a visit with a practising wildlife biologist. For example, if students are visiting a wolf biologist they may get a chance to visit an old wolf kill site and see for themselves that wolves play an important role in providing food for many other species. Biologists estimate that more than 20 other species feed on wolf kill sites, especially in the winter. If a member of the local pack is radio-collared, students can participate in locating the animal by using a directional antenna.

Field Trip Logistics

Some field trips are more equipment-intensive than others. Creating field trip packages as we have done, with one set of equipment used over and over, reduces the costs for everyone. We rent equipment if it is not readily available from the school or school board. With a larger program, we might approach potential sponsors and get grants to keep costs manageable. We use grants for capital equipment purchases and use student fees to cover ongoing costs for on-site staff wages, vehicle rentals, insurance, advertising, phone calls and classroom materials.

Safety is always important. A River Watch trip begins with a lecture on water safety and managing the rafts; then we outfit everyone with life jackets and rain gear. Each raft, which holds 15 people, is equipped with a first aid kit and rescue gear. We take a cell phone on each trip so that we can call in outside help if necessary. Each student is expected to bring a daypack with extra clothing, food, drinks and sun screen.

The pilot field trips showed us how many activities we could include without exhausting the students' attention. Three testing stops by raft, in addition to the water safety talk and a brief tour of the water treatment plant, seem to be all the kids can manage. A group of 10 to 15 students to each adult seems to create a supportive learning environment and manageable group size.

There are a few more things to consider in the planning process. First, avoid spending more time on the field trip than you need. Many facilities book groups for two-night weekends, when the actual field trip activities only last for six to eight hours. Why not keep it to a day trip then? Keep it local, too. A trip to a downtown river, or wooded area 15 minutes away has as much potential for worthwhile observations and activities of environmental awareness, human impact and science as a mountain or wilderness area hours away. We recommend avoiding any activities, such as simulation games, that could be done just as well in the classroom or school yard. Our field trips provide a learning environment that cannot be duplicated in a classroom, textbook or virtual environment.

Education in the real world is valued by students and parents, and the funding for a quality experience can always be found through fees, fundraising, sponsorship or scholarship. Make sure that you charge enough for the trip! Nothing is worse than setting up a field trip only to find that you are $200 short. Costs to consider include transportation, an honorarium for any lecturers, subsidies and rental costs. A contingency of 5 to 10 percent takes care of all the little details that get overlooked, but centralizing all the necessary equipment for a curriculum-based field trip significantly reduces the cost per student. The contingency percentage charged to all students can also be used to subsidize several economically disadvantaged classmates.

Field Trip Promotion

With the design and logistical planning done, we set out to promote the field trip program to both students and teachers. We visit conferences and run workshops about the River Watch trip for teachers, demonstrating how it fits into the curriculum, that it is not an add-on, and that it covers core curriculum material. We send a brochure around to every teacher teaching science, environmental awareness and outdoor activity in the city. The teachers get a great day of learning already prepared. All they have to do is book a bus and sign up.

We also need to promote the field trip idea to the students because if they are not excited, their parents will never hear about it. Teachers working with

their students are the best vehicle to generate enthusiasm. So, we visit classrooms to talk about the trips. The class hears about the adventure and the science, and is usually pretty keyed up by the time we finish our presentation.

Part of promoting the idea is the package of materials and handouts we supply to each teacher. This includes a video and a newsletter template, ready for the school's crest and the field trip dates, already containing all the information parents need to know to prepare their child for the trip. Depending on the trip, this newsletter may run eight or nine pages. It finishes with a permission sheet for parents to sign.

As we developed River Watch, we created a binder of classroom-ready material that we send teachers a week or two before their trip. In it are pre- and post-trip worksheets, problems about fish and water, and quizzes. We reproduced a series of newspaper articles covering a recent controversy over water usage as reading material with a list of questions to answer. There are a variety of activities, enough to suit every ability or learning style.

All this material helps a teacher prepare his or her class for the trip. So when the students arrive, they know what to expect, and they're ready to learn the science we're going to be doing that day. All the planning comes together to create an engaging learning experience and some great memories.

We know a field trip is successful when we see the students excited about learning, when they do well on follow-up tests, and when parents tell us how much their children talk about it. Our field trips are so popular they are used as incentives by other teachers to ensure their students complete their class assignments and homework!

LIFE, LAUNDRY AND LEARNING

ROBERT SHARP
F. H. COLLINS
SECONDARY SCHOOL
WHITEHORSE, YUKON

Robert Sharp has been involved in Yukon education for the past 30 years as a teacher, administrator, researcher and curriculum developer. During this period, Mr. Sharp became increasingly interested in finding ways to make education more engaging and effective for a wide variety of students.

He has created a school within a school at F. H. Collins Secondary School in Whitehorse. The Experiential Science 11 program he developed was designed to engage students and increase the value of their educational experiences. The program integrates seven subjects around a variety of study themes. Mr. Sharp's students face an intense but varied program that includes more than 35 field days every semester and two days each week working in college science labs.

Engaging students in real problems and field studies has proven to be very popular and successful: only one student has withdrawn from the program in four years and attendance has averaged more than 95 percent. More than one third of his students are on the honour roll, and another third improve their marks from Grade 10 by more than 10 percent. Mr. Sharp also ensures that a wide variety of students can take his course. He bases admission on attitudes as well as marks.

Robert Sharp teaches one of the five school-within-a-school programs currently operating in Whitehorse. He will admit that what he does is unusual. He teaches six or seven subjects to the same group of students for a semester that includes 35 or more days of field studies and two days a week at college laboratories. During field studies, another person accompanies him.

As unorthodox as that may sound, Mr. Sharp is quick to point out that the whole program is based on three principles that all effective teachers share:

- engage the kids' attention by making subject matter meaningful, adventurous or, ideally, both
- broaden the basis of teaching methods to accommodate students who learn best in different ways, such as by doing or by working in groups
- integrate topics so that students can understand what they study in a larger context.

Mr. Sharp is an advocate for the kind of program he and his colleagues run — he is quick to point out that he is only one of a group of teachers doing this. Below, he explains how they organize and finance the program.

EXTENDED FIELD STUDIES THROUGHOUT THE SEMESTER

At its base, these field studies are structured learning programs — they have to be to work — but they feature a structure different from what is typical of most courses.

We are a group of six individuals teaching different school-within-a-school programs. Each program is organized around a central theme such as sciences, arts or social/cultural studies. We wanted to provide students with experiences that would enrich their learning experiences. In the Experiential Science 11 program we included an extensive field studies program, examining marine life in an intertidal environment on the coast, for example, because it is an effective way to teach kids. The problem with field studies of this sort in conventional settings is that you have to take kids out of the school for a whole day, and when a biology teacher does that he or

she risks angering the English, social studies and mathematics teachers who lose a teaching period.

Our solution to this is to combine a group of subjects together and have the same teacher teach all of them to the same group for a semester. To make this possible we have to pick a group of subjects that lend themselves to field studies, that present opportunities for integration and that fit the strengths of the teacher leading the group.

To continue with the marine studies example, our Grade 11 biology course comprises a survey of living organisms, genetics and population ecology. About a third of this content focusses on the marine environment. This part of the program is ideal for field studies and by doing some travelling — the coast is some distance from Whitehorse — we can cover it effectively. We conduct intertidal studies, take part in a scuba program, sailing and sea kayaking. Students approach these studies by examining problems associated with the intertidal environment. They learn conventional field methods, prepare scientific illustrations, develop an understanding of ocean dynamics, record results, duplicate the research undertaken by others and debate field methods.

A biology semester with a heavy emphasis on field studies in marine, aquatic and forestry environments integrates well with an art program because students can sketch every organism they study. The same is true of a geography program in which students can draw certain land features, and so forth. On the other hand, a chemistry program does not fit so well with an art program because there is less opportunity for students to study the subject matter from an artistic point of view. Although it's possible to draw molecular structures you do not get the benefit of having the real object from which to work. In biology and geography, one of the important lessons that art teaches is that things never look the way they are pictured in textbooks.

Another subject that integrates well into field studies in science and art is our applied skills curriculum. We teach kids how to do a wide variety of things that are of direct use and benefit in resource management and conservation, such as water-quality sampling and forestry management. An added benefit for the students is that these skills are in demand for summer jobs in this area. That brings me to another area of integration, the Career and Personal Planning (CAPP) program.

CAPP is intended to give kids a chance to explore different career opportunities, to learn about the work environment, to discover the opportunities presented at college and university and to master the skills they need to manage their lives when they leave home. In our program, the students visit universities and colleges, meet about 40 different scientists, some of whom work in university labs, and carry out tasks typical of some professions. All the while, they have to do their laundry, cook meals and learn to get along with their colleagues. That alone effectively covers a large part of the CAPP program.

The other consideration in choosing courses is the strength of the teacher. For example, I know I cannot do justice to French or music, so those subjects are not included in the semesters I teach.

All the combinations we use are the result of considerable experimentation. My colleagues and I are always trying new ideas — keeping the ones that work — and sharing successes and failures. Much of what I describe above has been figured out over a number of years.

In each case, however, we cover these subjects in a different way from how they are usually handled. If you compare our teaching to the first 140 pages of a textbook, for example, we seem to be jumping all over the place. That does not mean that we reject structure; rather, we simply replace the textbook structure with another way of organizing class material that we feel is more effective. We substitute the book's order with a course organized around a thematic activity that kids understand quite well.

One of the tools we use to keep our activities organized is a field journal. Students receive one of these for every subject area. They are not textbooks, but are more than notebooks. The journal for chemistry, for example, has a laminated copy of the periodic table, a section for notes, a place for labs and exercises all in one bound book. For art, we include a pocket for watercolours, a series of exercises and blank sheets for sketches. The marine studies booklet has about 20 exercises that kids do in the course of the program.

I tell the students that these journals will help them organize the things they have to do. They are also a mechanism for launching memories after the work is done.

To recap, we take a central theme, such as marine studies, and we build other programs such as arts and applied skills around it. The next step is to see what kinds of field studies there are that we might do. For example, I might contact scientists working with oysters and ask how they study larval survival in oysters.

It is also a good idea to pay attention to what is happening in the newspapers when planning field studies. In the Yukon, for example, there have been a number of articles related to forestry issues. So, we get in touch with the people researching forestry concerns, such as seedling growth and forest composition, to see how we can work our applied skills curriculum into what they are doing.

Selling this approach at your school

I believe that this approach can be used at schools right across the country; however, there are some limitations. To begin with, this approach is best in Grade 9 and up when there is some specialization in subject areas and the sciences have been pulled out into specific courses such as physics, chemistry and biology, for example.

It also works far better at a school that uses the semester or quarter system. In the linear or term system it is hard to break a group out of other studies for an extended period. Also, you cannot cover every subject adequately all at once using our approach. I might, for example, teach biology, chemistry, applied skills, fine arts and CAPP in one semester,

leaving the students to take English, social studies, math and French in the other.

I realize this approach will be a hard sell for some schools and many teachers will wonder if there is a way to apply the program in a limited way. I think that is possible with one proviso: you cannot do this in a single class. You have to integrate a number of subjects for a specific time period for our approach to be effective.

Financing

The other obvious concern is cost, but here I have a big surprise. This approach is actually cheaper than running a traditional teaching program.

For example, traditional programs do not provide food and lodging to students like ours does, so it is reasonable to share these costs with the kids and their parents. Each student has to provide and prepare a set number of meals for the entire group. (This is also a great opportunity to teach life skills in the CAPP curriculum.) All accommodation is either at the school or campgrounds so the cost is virtually nil.

Similarly, students are generally expected to pick up the costs of their extracurricular activities. In our program there are a number of external certification activities, such as coastal cruising, sea kayaking and SCUBA courses. The students pick up the costs for these too — about $350 each per semester.

We transport the students in school vans, the cost for which, at our school anyway, is covered by the normal operating budget.

That leaves us with some extraordinary costs, such as for the long ferry ride down the coast. We pay for these by taking on contracts related to the curriculum. For example, there is a demand for seed cones for various forestry programs here in the Yukon. Each student gets a quota of bags of cones to collect. This teaches students valuable applied skills as well as a lesson about the discipline required to get a job done and the payoff that comes with it. After doing these sorts of contracts for a number of years, we have reached the point that people come to us with offers.

Another major expense is a second teacher who assists the group leader. We finance this position by pooling the prep money for the courses being taught. (By the way, we try to work in teams of one male and one female teacher because we spend so much time in isolated situations with the students.)

One of the best arguments for the program is the effectiveness of each dollar spent. I suggest that school administrators count the number of students who finish a program rather than the number who register when calculating costs per student. Our attrition rate is virtually zero. I think we have had one student drop out in four years. When you know students are going to stick with the program, you have used your resources wisely.

PREPARING STUDENTS FOR THE REAL WORLD

Approximately three quarters of Canadians go no further in their education than high school. The problem, as many educators have recognized, is that although the knowledge taught in high school is important and useful, students do not spend a lot of time learning how to apply it. When graduates get their first job, they often have no idea what to do. The successful ones either figure it out for themselves or have employers willing to train them. Others struggle with the most important problem-solving situation in their lives.

Although many people have recognized and talked about this problem, a few, such as **Garry Kroy** and **Ted McCain**, have really effective solutions. Mr. Kroy tells us how he has made school and community needs into real-life problems for his students. Mr. McCain, on the other hand, explains how he uses role-playing to make classroom problem-solving more like what happens in the workplace.

LETTING STUDENTS HELP THEMSELV

GARRY KROY
AUSTIN O'BRIEN HIGH SCHOOL
EDMONTON, ALBERTA

Austin O'Brien High School's profile in the community was raised considerably when Garry Kroy took control of the Career and Technology program in the early 1990s. His students have achieved international recognition and their success has helped attract more students to the school, which had been suffering from declining enrolment.

Mr. Kroy created a laboratory where students can use technology, which encompasses traditional and state-of-the-art tools and computers, and learn about possible careers. He laid the foundations for more than 90 learning modules in which students explore career options.

Students from all fields — from sciences to drama and art — and of all learning abilities use the lab regularly. Mr. Kroy also developed a modular system so that students can follow a program of their own choosing that gives them the skills they need to make future career choices.

"Can I go straight to work?" That is a common question in Garry Kroy's Career and Technology Studies (CTS) class, which gives students experience in a variety of career areas. His students are eager to get started because many of the things they do in class are real-life jobs that help their school and community. Mr. Kroy has taken advantage of the equipment he uses to allow students to put their newly acquired skills in electronics, computer-assisted design, desktop publishing, radio, video, silkscreening, sign making, animation, robotics, welding, construction and the Internet to work.

He has also made effective use of the new CTS curriculum in Alberta to create a facility and a program that introduces his students to a wide range of workplace skills. Since arriving at Austin O'Brien High in the early 1990s, he has turned everything from minor crises to extracurricular activities into learning opportunities for his students.

Here he tells us a little bit about the situation he found himself in at the beginning of the decade and how he built an inspiring new program out of the opportunities he saw.

MEETING SCHOOL NEEDS WITH CLASS PROJECTS

I was lucky enough to arrive at my school at a time when there was a tremendous opportunity for growth; however, it did not initially seem that way. In the early 1990s, enrolment was declining and the board was considering closing the school. What I found when I got here was not a staff in despair, however, but a dedicated team of educators keen to save the school. Being a part of the team that helped turn around Austin O'Brien High was very inspiring and had a powerful effect on the way I work.

I was able to add to the spirit of cooperation and teamwork by having my students help out with school and community projects. Because the practical skills and the equipment we use in CTS are useful for many of these projects, I was able to have the students contribute and perfect their skills at the same time. Also, a number of local organizations and businesses have given financial and staff support to our programs. Our partnership with the *Edmonton Sun* has

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helped our school newspaper immensely. A local Knights of Columbus club has helped us purchase major pieces of equipment that keep us on the cutting edge of new technology.

The academic basis that made it possible to integrate these projects into the curriculum was the new CTS curriculum in Alberta, which allows students to work on individual modules that develop specific knowledge, skills and attitudes. With this curriculum, I work with my students at the beginning of the year on problem solving, team building, and design skills before turning to the modules — which students can work on individually or in groups — that will help them discover their interests and abilities.

The modules are well designed and motivate students to progress to intermediate and advanced skill levels in many career areas. We have been able to add to the benefits provided by the new curriculum by putting together a great facility here. Our students have access to a large number of the approximately 620 modules available in the Alberta CTS curriculum.

The curriculum made it possible for me to include a series of additional projects that allow students to integrate the skills they learn. These projects carry on the team spirit that has made such a difference at Austin O'Brien. Some examples of the work my students do are photography, word processing and desktop publishing for our school newspaper, producing videos for the school or community, designing and printing T-shirts for a sports team, welding a broken part on a piece of gym equipment, producing a short radio program to promote a school activity, growing plants at the hydroponics station and using computer-assisted design tools to design community building projects.

Most schools should be able to do similar integrations of career and technology studies curricula because of something all schools have in common: there is always a whole raft of things that need to be done and not enough people with the time to do them. Technology teachers are particularly well placed to take advantage of this situation because we typically have the facilities to do so many things. It also presents a great opportunity for our students to work on something applied rather than another prepackaged project.

Students respond to the challenge that real-life projects present. They do a better job when they can see that what they are working on matters to them and to the rest of the school. The whole experience is also much closer to what they will find when they join the working world.

Finding opportunities for students to help is not hard. Just off the top of my head, I can imagine a whole slew of situations that could be integrated into my curriculum. For example,

- a school sports team wins the provincial finals and members would like a T-shirt to commemorate the occasion
- the drama department is doing a play that could use some impressive special effects
- students from a design class would like a video to show off their achievements
- a community project needs a Web page.

In fact, if you get a reputation for helping out, you don't need to make an effort to think of opportunities any more. They will come to you.

What you do need is to be organized enough to match up students and projects. You also have to let other teachers in on the logistical problems and challenges you face so that they will know to come to you in enough time to get the project done.

When I first started my program, I focussed on one type of project. I picked a particular area of expertise and developed it from there. A teacher could begin with just video, or audio or small construction projects. Once you have the logistics down pat, you can branch out.

When considering a new project, the first thing I do is go through the list of students and the modules they have completed. The most important thing is to match students with appropriate skills to the job so they won't find it too challenging or too simplistic. A team halfway through the sign module, for example, is the ideal group to create a banner for graduation.

In addition to the skills from the modules, the problem solving, teamwork and design skills we covered at the beginning of the year get integrated into the projects. I outline the proposed job to group members to make sure they buy in. They usually do because they have considerable incentives for doing so. For starters, I have made room in my evaluation for additional marks for this kind of work. Many times, the school or community group will add their own incentives, whether that be a dinner, a small payment or even an interview for a future job. Finally, the students get to contribute to their school and community.

The students then go through a problem-solving process. They talk to the clients to find out what they need, have a brainstorming session and then develop a proposed design. Once everybody approves the design the students carry out the actual work. Afterwards, the students critique their work and talk about how it might be done better. If it is a recurring project, the feedback will be documented so that next year's team can take advantage of past experience. The other major benefit is that the client will pay for all materials and many times provide extra funding for our program.

There is a lot of enthusiasm among students for client projects. Sometimes students who have already finished the program will help. Unlike other work we do in the class, I do not have to make this stuff seem like a real-life situation — the students already know it is. If they are making a banner for their graduation, for example, you can be sure the students will do it professionally because all their friends are going to see it. In addition, each student leaves the class with a portfolio highlighting the knowledge and skills that he or she has developed.

FROM ROLE-PLAYING EXPERIENCES

TED MCCAIN
MAPLE RIDGE SECONDARY SCHOOL
MAPLE RIDGE, BRITISH COLUMBIA

Ted McCain of Maple Ridge Secondary School in Maple Ridge is an energetic and vocal proponent of new technology in education. He stresses its potential for individualized learning, integration of disciplines, quick access to new information and the development of critical thought. He regularly updates colleagues and parents on new developments, delivers speeches and leads workshops. He is closely involved in curriculum design in his school district and province. Courses created by Mr. McCain have become models for technology education across the country.

In his Computer Science, Work Experience and Knowledge Architecture classes, he practises what he preaches by coaching his students rather than teaching them. He frequently poses as an uninformed customer, questioning his class to highlight the need for students to think creatively and to have a firm grasp of concepts. He provides hands-on experience, real-life work training and advanced academic challenges; his students thrive.

One of the defining moments in Ted McCain's career came when he asked one of his better students a question from a test that the student had written two weeks previously. Despite having scored in the 90s on the test, the student was unable to answer the question. That set Mr. McCain off on a deep questioning of just exactly what students were learning in his classes.

He knew one thing for sure. He did not want to go on teaching students how to pass tests only to have them forget everything they learned. The problem lay, he realized, with the system and not with the students. The system is amazingly insular and has an overwhelming focus on simply preparing students for the next grade without making much of a connection to the real world. The student who performed so well on the test demonstrated this. He had shown a highly intelligent response to the demands put on him: he had learned what it takes to do well on tests, but it had little lasting positive effect in terms of preparing him for the rigours of the modern workplace. The challenge Mr. McCain set for himself was to work out new ways of challenging students that would force them to develop skills that are more useful in solving real-world problems than cramming their short-term memories to pass a test.

Mr. McCain drew on his experience in the private sector, as well as his professional skills as a teacher, to work out a number of innovative strategies for leading students to learn skills that will prepare them to make their way in the world. Here he not only describes one of these approaches, but he also explains the way he initially thought about the issues that led to it.

WHAT AM I REALLY TEACHING?

I know I am not alone in wondering whether my students are getting much out of what I teach them. This is a question that every responsible teacher constantly asks themselves.

I teach students in their final years of high school and my classes deal with technical skills such as computer science, information management, multimedia production and Internet publishing, as well as career

TO REAL-WORLD JOBS

preparation. I was aware that, despite the overwhelming emphasis on preparing students for post-secondary education, the majority of students in the public school system end up getting jobs with what they have learned by the end of Grade 12. Thus it was natural for me to get input from the people who employ students when they graduate. One of their recurring complaints really hit home. I heard over and over again from employers that new employees have a strong tendency to wait to be told what to do.

Knowing this, my next challenge was to figure out exactly what was wrong with the way I was teaching my students. The employers saw something but it was my problem to figure out how to better prepare my students so they could succeed in today's world.

The problem is that students too often develop skills that are highly effective in school, but what we really want them to do is develop skills they can use in the world outside the school walls. By the end of high school students have become very conditioned to rely on the teacher to tell them what they need to know. Not only are they used to working this way, but they have also become very good at it. The challenge then is to develop ways to force students to think for themselves.

THE USE OF ROLE PLAYING

I had two goals: to foster independent learning and problem-solving skills in my students, and to provide a link to the real-world workplace that students will encounter after they leave school. I discovered that role playing accomplishes both of these goals. I don't use it exclusively; it is just one arrow in a quiver of instructional strategies that I use to hit pedagogical targets and one that can be easily adapted to any existing program. I use it in my technical courses but it can be easily applied to other subjects such as social studies, science or language arts.

I conduct a business meeting in class as if I were somebody other than a teacher. I might, for example, own a shop that sells off-road motorcycles and parts and that needs a Web page. Alternatively, I might be a magazine publisher looking for a new computer system that will allow my editors to work more closely with freelance writers. While in character, there is a whole raft of questions that I either can or cannot answer, or might answer differently than a teacher would. The dirt bike shop owner, for example, is not going to be able to answer questions about HTML scripts. If my students ask the publisher whether he

wants a local area network, he is likely to respond that he hired *them* to answer that question.

The point here is to cut students off, temporarily, from my expertise as a teacher of a certain subject. This forces the students to begin thinking for themselves. It also forces me to shift the focus of my teaching. I can't just give the students a problem and watch as they flounder. I have to equip them with an understanding of the basic steps to follow when solving problems.

The role playing will succeed in solving the problem as I have defined it above (that is, forcing students to think for themselves) if it produces a number of results.

First, it should make students quick to react. They should know to start listening as soon as one of my role-playing selves describes a real-world problem. They should take notes. And they should start asking questions that will help them determine this person's problem.

Second, this approach will have succeeded if it changes my role as a teacher. If the students really are self-starters they will see me as a resource for certain kinds of information. On the other hand, it will fail if they successfully resort to tried-and-true tactics that either weasel the answers out of me or lead me to jump in and start solving problems myself.

Finally, if the problems that my role-playing self presents to students meet curriculum and pedagogical goals, then I know I've done my job.

Doing It and Evaluating the Results

There is no formula for role playing. You simply research the part to prepare yourself as well as possible and then do it.

It is important to note that one of my primary goals in presenting problems to my students in this way is to create the confusion and paralysis that is usually experienced when young people are presented with a problem to solve in their first job. I want this to occur in my classroom because then I can teach the students the process required to develop successful solutions. By the time students leave my classroom, they should be able to step seamlessly into the working world. I teach students that there are four basic steps they must follow:

- figure out what the problem really is
- plan a way to respond
- do it
- evaluate what happened so that you can do better next time.

Obviously, there is much more to it than that, but this is the basic framework that gets elaborated with each problem the students solve. The important thing is to get an organized way of working, whether as an individual or as a group, and apply it to real-world problems. You can — and should — go on perfecting the process every time you use it.

This brings us to the final step, evaluation. Obviously, for a problem solver that means getting useful knowledge and skills out of the experience. It also means determining the criteria against which to measure a student's performance and assigning a mark to that performance.

The evaluation criteria come from the planning stage of problem solving. I set out a few above when I talked about the things that would show that my role playing had succeeded. If I find, for example, that my students coaxed an answer out of me shortly after the role playing was over, then I may want to figure out some reason to leave the class next time to let the students work on their own.

For those of us who are not professional actors, one of the major concerns is evaluating our performance. In my role playing (which was not great the first time I tried it), I rely on my experience in business and as a consultant to play the part. If necessary, I ask actual business people to help me when I find in my self-evaluation that I don't have the knowledge to do a part convincingly.

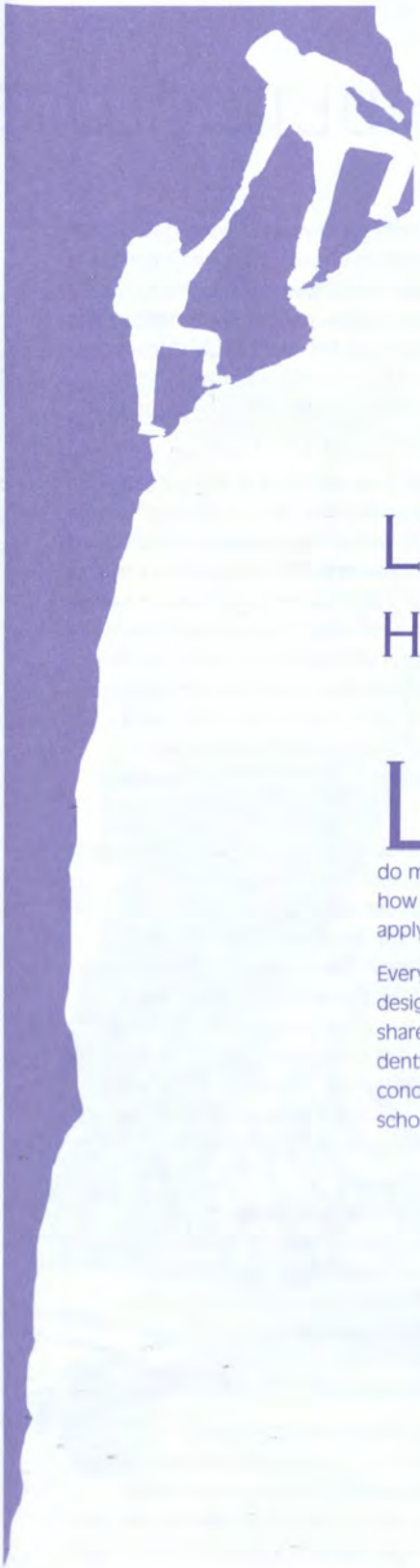
A similar approach works when evaluating student performance. Students set out, in determining what the problem is, a series of targets or objectives. The next step for the teacher is simply to ask them to evaluate themselves by writing out an assessment of how well they did in meeting those objectives.

They then sit down with me and I discuss their performance with them, agreeing if I think they are right and explaining when I think they might have undersold or oversold themselves. Just as in a real-world performance review, the students leave these discussions knowing that they want to improve in a number of areas and knowing that I want to see them incorporate those objectives into their next problem-solving plan.

Continually Stepping Back

I have discovered one other important piece of the puzzle of teaching students to become independent problem solvers: continually stepping back from the process. I compare this to teaching a child to walk. At first, you hold children's hands to keep them upright, but as the children become more practised, you get them to walk on their own, first for very short distances and then longer distances as they become more sure of themselves. I do the same thing with my students. At first I am very involved in holding their hands throughout the entire problem-solving process. However, as the students become more skilled, I purposely step back from my involvement in developing solutions and I continue to step back until I am no longer needed at all.

As a teacher, I want to provide support for my students without making them dependent on me. I succeed if they take the skills they need to succeed with them when they leave my class. Statistics tell us that most of our graduates are going to be entrepreneurs working in small companies. Role playing is only one of many strategies teachers can use to help students step from high school into the working world.



LEARNING HOW TO LEARN

Learning does not stop when a graduate is handed a diploma. In fact, today's jobs require people who are willing and able to learn for the rest of their lives. To succeed in this environment, students need to do more than acquire knowledge while at school. They need to understand how they learn and to acquire useful strategies for learning that they can apply themselves after they leave school.

Everything the students of **Randy Cook** and **Maureen Flynn** do in class is designed to help them develop lifelong learning skills. Here the two teachers share just a few of the approaches they use. **Frank Jenkins** teaches his students about knowledge itself, and he shares some of his ideas for teaching concepts from the study of knowledge, called epistemology, at the high school level.

ED HATS

at. The first task of the day is for the students to compare their ideas with their fellow students and with us. This gives everyone a chance to meet one another without any preconceived ideas about their roles.

Beginning this way also builds a new kind of group dynamic. By talking about what they are good at and what they would like to be good at, the students inevitably see that their various strengths can be complementary. If a boy who has always felt shy talking to adults, for example, meets a girl who is an expert at selling Girl Guide cookies, he can see that she may be able to help him.

The next activity of the day is to create a code of ethics — a commitment from the students to the expectations they will try to live up to during the school year. Before they have done a single bit of work, we ask them to assess themselves. We ask, What is it that you want people to be able to say about you and how you work?

The objectives that students set for themselves during these discussions are written down in an individual learning log that they each receive. We come back regularly to the objectives in the students' code of ethics throughout the year and ask them how they are doing at meeting their goals.

The students also use the log book to keep track of their progress on the academic and social objectives they set with their instructors every day and before each period. At the end of a period the students make notes on what they completed and, in addition, they write a half page about it at the end of the day. Included in this end-of-the-day summary is a description of their most significant learning of the day.

An instructor then reviews the log with the student. Obviously, if the student has written that he or she learned nothing or not much, the instructors asks why this happened and what needs to be done to change this tomorrow.

This will sound reminiscent of performance reviews used in the workplace, and that is no accident. Our curriculum is based on the employability skills identified by the Conference Board of Canada. The students learn very quickly that there are three areas from the employability skills reflected in our curriculum: academics, teamwork and personal management. Setting and meeting goals is a prime example of personal management.

The other lesson that students learn through the regular review of their log books is that the results of their work are what matters. We had an interesting experience with the learning logs that illustrates this nicely. We wondered if we could help the students by providing standardized learning logs. The problem we quickly ran into was that everyone fills out their log differently. Some people like to use a very formal structure with headings and others prefer to ramble on. In the end, the best format for everyone was blank pages. The approach the students take to organizing themselves is not as important as whether their approach helps them get their work done.

When discussing objectives for a period, our instructors tell the students about the curriculum goals they want to meet. At each session, the instructor will establish the goal for that session, which the students record in their log book along with their personal goals. As sometimes happens in the classroom, the discussion will lead us away from the intended goals, but the students know what curriculum areas need to be covered and they know that it is their responsibility, and not just the teacher's, to make sure this happens.

This all feeds very easily into evaluations that we do periodically throughout the year. The students write out a self-evaluation that they discuss with peers and then with us. Because they have been through ongoing assessment in their log books and have hashed things out with others, they are pretty confident by the time they talk to us, and they should be. They know what was expected of them and they how well they were doing at living up to their commitments.

It is important to note that we still make use of many traditional assessment techniques. Our students regularly write tests, for example. We do this because tests work when used the right way. An important part of any curriculum is acquiring certain bits of knowledge, and the best way to make sure that people have gotten those bits is to have them write tests.

HAT TRICKS

Knowing things is important, but knowing what to do with that knowledge — knowing how to acquire it when you don't have it — is more important. That is why we put so much emphasis on teaching our students how to learn. The code of ethics and the logs are examples of these. We go further than that, however, and teach our kids different strategies that they can learn when and how to apply themselves.

A good example of this is Edward De Bono's hats. He developed a colour code to act as a shorthand for remembering different ways of thinking. He classified six thinking processes with the following six hats:

- black hat: making decisions
- yellow hat: looking for the positive side of a situation
- blue hat: sorting and organizing
- green hat: creating
- red hat: emphasizing our feelings
- white hat: processing information.

If you teach the students about these different ways of thinking, they can learn to use them. They can understand that when they are all heated up from an argument, they will not be so good at considering what led up to that argument until they can calm down and replace the red hat with a white one. Or, if they are doing a research project and have reached a roadblock that is frustrating them, the instructor can ask which hat they need.

This helps them with group discussions and projects as well. The students quickly come to realize that you need many different kinds of thinking to make a project work. They know, for example, that there has to be someone on the team who takes notes and who can keep the project on track.

This is not all that different from a lesson we have learned as teachers. In our group of instructors, there are people who are good at keeping things on track, for example.

Perhaps the most important thing to bring to a classroom is this kind of order. On their first day, students enter what looks like a large, open-ended space, but is actually very structured. From that day on, whatever they do — whether they are working in the learning lab on computers, with a team on a project, or in the science and technology lab — it is all about producing certain results.

PERIODIC LAWS, ATOMIC THEORIES

FRANK JENKINS
ROSS SHEPPARD HIGH SCHOOL
EDMONTON, ALBERTA

Dr. Frank Jenkins, a chemistry teacher at Ross Sheppard High School in Edmonton, has spent his 30-year career helping students grasp the nature of science. He believes this is the key to developing a solid understanding of how science, technology and society mesh every day.

His classroom programs hone students' ability to think and solve problems. In one exercise, they read an article from a chemistry journal and highlight the language the scientist uses to express uncertainty and to appeal to authority. For example, the scientist might indicate uncertainty by writing "tentative results indicate," "based upon this one study" and "until further studies are completed." The authority might be identified by statements such as "according to the Lewis molecular theory," "based on the law of conservation of mass" and "according to the evidence gathered in this experiment." The challenge for the students then is to apply this process to their chemistry textbook and their teacher's oral and written lessons and tests (after, of course, the teacher has gained enough consciousness of and confidence in his or her scientific language). In such ways "Dr. J" involves his students in exploring new chemistry and epistemology concepts — simultaneously.

There are few things people take more for granted than the origin and nature of their knowledge. We use what we know when we need it and curse when we don't know enough. Knowledge is the common currency of our intellectual world and we tend not to wonder about it any more than we do about money, except, of course, in times of crisis.

Epistemology is a discipline whose practitioners wonder about knowledge all the time, rather than just when knowledge becomes problematic. Epistemology is the rules of the knowledge game teachers play with their students in every classroom. Practitioners consciously concern themselves with questions such as: What is knowledge anyway? Where does our knowledge come from? Where and when is it appropriate to use it? Frank Jenkins is one of a few pioneering teachers who introduce high school students to epistemology, usually a university-level subject. As he tells us below, high school students often ask questions that sound much like the ones philosophers pose.

AND EPISTEMOLOGY

There is more to epistemology than speculative issues, however. Dr. Jenkins also explains how epistemology can help students become more effective learners.

How can I know? Let me count the ways.

I started using epistemology to help my students learn mostly because I think it helps them to learn better. The more ways someone knows something the better they know it, but first you have to know what ways of knowing to look for. Beyond that, there are three factors that led me to apply it in chemistry classes.

First, chemistry, as I will explain later, is particularly well suited to introducing epistemological questions in a way that is immediately relevant to what students are studying.

Second, there is the troubling tendency of high school science textbook authors to frame knowledge in purely theoretical terms. This leads students to think that theories are the only things we really know or represent the best way of knowing. In fact, much of what we know is only empirical concepts — generalizations or laws based on empirical observations.

Finally, I, like all teachers, need to deal with a perennial student question: How am I supposed to know that? I have heard that question more than once in my career and have sometimes had to struggle to answer it or, in my less inspired moments, have tried to gloss over it.

THE USE AND ABUSE OF CLASSIFICATION SYSTEMS

Chemistry is easy to link with epistemology because classification systems are so important. We use a variety of ways to group and describe chemicals — metals and non-metals, acids and bases, solids, liquids and gases. Classifications like these are a particularly slippery kind of knowledge. Virtually every classification system breaks down in some circumstance and that leads us to question how we really know something if our knowledge is based on something uncertain.

Consider, for example, the periodic table of elements.

In chemistry you may teach the periodic law by referring to a whole series of subatomic theories. Students learn about the periodic table by studying things that are not observable — atoms, molecules, electrons and intermolecular force field theories. If we constantly teach this way, many of our students come to think that theoretical learning has a higher value than empirical knowing, and even comes first.

Historically, however, scientists originally created the periodic law through a series of empirical observations. In fact, two 19th century scientists figured it out simultaneously. Lothar Meyer, working in Germany, arranged the 57 elements he knew about according to atomic masses and generalizations about the properties of the elements, and left spaces for elements that had not been discovered yet. Meanwhile in Russia, Dmitri Ivanovich Mendeleev did something similar using the chemical properties of the elements. He not only left blank spaces for the missing elements but he also predicted what the chemical and physical properties of these elements would be when they were found. These predictions were tested and verified 16 years later and led to the acceptance of Mendeleev's periodic law.

Meyer and Mendeleev knew the periodic table in a different way than we do, but no one could say they didn't know it because they weren't familiar with the theoretical explanations that other scientists came up with half a century later. I like to show my students that we can know the periodic table either empirically or theoretically, but that they may find, depending on their goals, that sometimes one way is better than the other or that they are complementary.

Historically, the empirical way of knowing most often led to the theoretical and the theoretical sometimes changed the way we understood perceivable things.

Consider, for example, metals and non-metals. This distinction was used to classify elements in the earliest versions of the periodic table. It was — and still can be for some applications — a useful initial way of classifying elements. But we have trouble with the empirical definitions of metals and non-metals when we first encounter carbon as graphite, which is dull and brittle but conducts electricity. It does not easily fit into our normal understanding of metal.

Chemistry is an ideal subject for introducing students to epistemology precisely because we often run into issues like this. The division between metals and non-metals does not exist in nature. It is an artificial classification system that was invented by human beings. As Einstein would have said, "It is a free creation of the human mind." But then, of course, we have to wonder how we know anything if our classification systems are artificial. How can something created by human beings apply to the real world?

I always ask my students why we classify things. Well, we do that to help us organize our knowledge. Students begin to see that these concepts (and generally, the earliest organizing concepts are classification systems) are for our convenience. All classification systems exist because they are useful for doing chemistry, and they evolve.

My students come to see that there is no such thing as certain human knowledge. Our classification systems and an awful lot of human knowledge that comes from the classification of stuff are human inventions. This is very different, however, from saying that we don't know anything. Of course we know things, but we never know them absolutely. We can build upon our understanding and we can reduce the degree of uncertainty, but we can never reach something called absolute knowledge. I always tell my students to be wary of those who lay claim to absolute knowledge — these are the dangerous people in our society.

That is important because in science we do not acknowledge this uncertainty often enough. At high levels, such as in journals of theoretical physics, it is done but in high school chemistry it is not. When students read a Grade 10 chemistry text, they do not often see any acknowledgement of the fact that a particular theory is just one way of understanding the world. What is more, if the chemistry teacher just teaches the subject without thinking about the hidden epistemological messages, he or she will do the same. It is impossible to teach without conveying a view of the origin and nature of the knowledge being presented.

The situation is analogous to values. Even if you never say a word about your value system in class, you will inevitably convey that value system to your students because everything you do is framed by those values. The way you respond to questions, how strict you are about late work, and the amount of time you have for students who are struggling, all demonstrate your values to students. Epistemology is the same way. You have a series of core beliefs about what counts as knowledge and you convey those core beliefs to your students in everything you do.

Suppose, for example, that I value truths that can be backed up with mathematical formulas. Even if I never tell my students this, they are going to see from the way I treat the application of mathematics to chemistry that this is what I think really matters.

The truth, of course, is that we all teach students things that we know are not really the best concepts. When primary school teachers introduce students to arithmetic, for example, they teach numbers knowing full well that they are giving a very incomplete notion of them. Later we shatter these simplistic notions with concepts such as fractions, rational and irrational numbers, and integers. If they go far enough in mathematics, students will eventually run up against imaginary numbers!

We do something similar in chemistry when we teach students to distinguish between acids and bases using concepts we know are incomplete. When we teach a more complete theory, students sometimes ask why we didn't just teach them the second theory in the first place. The simple answer is that this way is just a useful way to teach. A slightly deeper — and more honest — answer is to get into epistemology, to tell students about the nature of knowledge, its evolution and some of its limitations. (And, as every chemistry teacher knows, this second theory of acids and bases is also inadequate. There is another more complete, but still uncertain, theory coming at the university level.)

How am I supposed to know that?

Epistemological enquiry has a very practical purpose in the classroom. Consider our original student question — How am I supposed to know that? What do you say to this student? One interesting response is to turn the question around. Every student knows that H_2O is water. But how do they answer the question when you ask them how they know that?

The answer is actually terribly obvious, perhaps too obvious. They know it because they have memorized it. That, of course, does not seem good enough. Many people, for example, also know that $E=mc^2$, although most would be hard pressed to explain what it means.

One blackboard in my classroom never gets erased, and on it I keep track of these epistemological concepts. I include "memorization" on the list as one of the ways we can acquire knowledge. It is a way of knowing and a perfectly good one in the right place. After all, how do you know your name?

Another way of knowing is to look things up — a referenced way of knowing. If students have a periodic table on the inside cover of the textbook then they can use it to look up all sorts of useful information.

Two of the more important ways of knowing for chemistry are empirical and theoretical. Empirical knowledge is particularly challenging because we all use it, not only in chemistry but in the rest of our lives as well, without really understanding it. I "know," for example, that paper burns if I heat it to a certain temperature and oxygen is present. When I say this, I really mean that I have seen this happen often enough to conclude that it will keep happening.

But what am I doing when I create this concept? Am I generalizing from a series of cases or am I applying some rule? I also discuss these issues with the class and include them on my special blackboard.

Understanding that there are different ways of knowing can be a tremendous relief for students because sometimes they don't need to know things theoretically. Often, we teach empirically but do not expect students to understand the theory behind the knowledge. Consider, for example, redox reactions. From doing experiments, my students have come to make an empirical generalization about these reactions. They know that if an oxidizing agent is above a reducing agent in the redox table we have constructed in the laboratory then the two will react spontaneously if brought together. For many, this does not seem like enough. As with memorizing that H_2O is water, the students feel like they ought to know about redox reactions some other way. But when I tell them, that *this is how you are supposed to know it*, they relax.

Where can teachers learn about epistemology

Unfortunately, many professional philosophers would make poor arithmetic or chemistry teachers. They want to teach everything about epistemology or nothing. For this reason, they are not very helpful or encouraging for high school teachers who want to teach only some initial epistemological concepts.

In high school, we don't want to overwhelm the students with too much epistemology for the same reason we use only a partial understanding of the concept of numbers to teach arithmetic to primary school students: we would only confuse them. If you go to the local library and look up "epistemology," you will most likely end up with something far too involved to be useful to you.

Fortunately, a group of science teachers in Britain has provided a practical alternative. The Association for Science Education has published a series of books called *Science and Society*, one of which, *The Nature of Science*, provides a great overview of epistemology in 67 pages.

I recommend the book for any science teacher. Even if you don't do anything with epistemology, the book will add to the ways you can explain concepts to students. It will increase your arsenal of teaching and learning techniques. Ideally, I hope you will pass the ideas along to your students as well.

HIGHLIGHTS FROM THE REPERTOIRE

Every graduating class has a few students who barely got by in school but who will excel in life. How is it that some people show an amazing aptitude for learning on the job but not in the classroom? It's not that they can't learn, for they have proven otherwise. Sometimes it is the education system that fails, rather than the students.

Bolstered by research about how people learn, some teachers have concluded that they need a variety of different teaching methods to reach all students for the simple reason that not everyone learns the same way. These teachers make it their responsibility to get the information to students and then use a variety of approaches until they succeed.

In this section, five teachers each share just one of their repertoire of teaching approaches designed to reach students who learn in different ways. **Yofi Sadaka** helps students discover scientific truths for themselves by starting from basic concepts and problems. **Richard Ford** also encourages students to discover things for themselves but does so by having them work in groups. **Bob Sanders**' mobile computer carts bring high technology and flexibility to the science lab, allowing students to learn in a variety of ways. **Pat Bell** has created a series of pictograms that make it easier for her students to see the logic and meaning of Latin. **Daniel Thorsley** takes advantage of students' natural competitiveness by creating contests that extend the curriculum.

BUILDING SCIENTIFIC CONCEPTS FROM THE GROUND UP

YOFI SADAKA
HERZLIAH HIGH SCHOOL
MONTRÉAL, QUEBEC

Herzliah High School in Montréal is far from ordinary. The students at this trilingual school study everything from the very foundations of Western culture to its latest scientific achievements. The first of these is covered in the school's Hebrew studies program and the latter is the responsibility of Yofi Sadaka, Head of the Science Department.

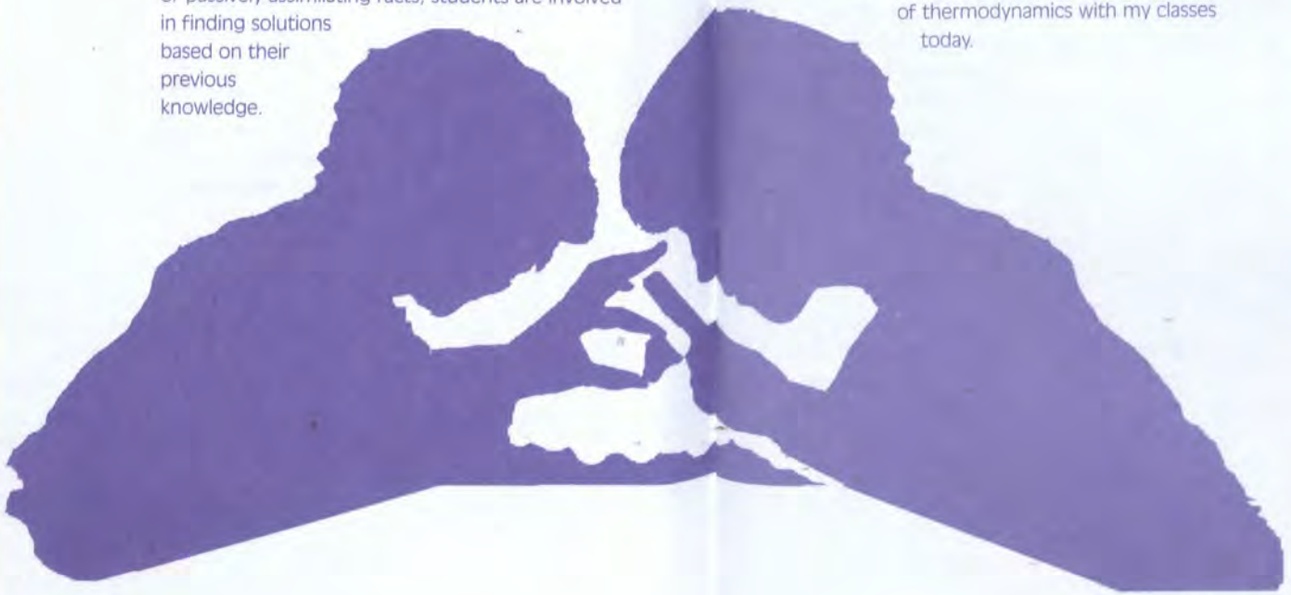
Mrs. Sadaka is always pushing her students to new heights. They are perennial winners in science fairs and last year reached an apogee when their experiment on the formation of barium sulphate precipitate was performed on the space station *Mir*.

Mrs. Sadaka teaches in both French and English and has worked for the province's education ministry analysing the discrepancies in student performance on ministry science examinations between the French and English sectors.

Yofi Sadaka wants to send well-balanced students out into the world. Her aim is to prepare students to be independent learners who can apply theories and skills in real-world situations.

In science class, she believes this means teaching students how to "do science" rather than how to be scientists. She does not think high school students are ready to be scientists but she does think they are ready to learn how to think about basic concepts and to make inquiries. She teaches them that science involves being curious, not taking things for granted, and looking around at the world.

Recent changes in the Quebec science curriculum require teachers to use a constructivist approach (sometimes also called an investigative or building approach). Here Mrs. Sadaka tells us how she "turned her teaching methods upside down" to adopt the new approach. Instead of doing an experiment "to verify" what has been learned, with this approach the students are encouraged "to construct" their knowledge by doing their own investigation. Knowledge is "built" from the conclusion of an experiment or by trying to answer questions. Instead of passively assimilating facts, students are involved in finding solutions based on their previous knowledge.



WHY CLEANING YOUR ROOM VIOLATES THE LAWS OF NATURE

Today, I teach science in almost exactly the opposite way from how I learned it. When I was in high school the teacher began by telling us about a scientific law. For example, we would be taught Boyle's Law (PV=constant) and that the value of the constant depends on the temperature and the amount of gas present. The teacher would then intone that when the pressure goes up, the volume goes down and vice versa.

Having learned the law, we then did an experiment that "proved" a hypothesis based on it.

The most dangerous thing about this approach is that it encourages students to rely on memorization exclusively. I use a more dynamic approach. I encourage the students to think about the relationship between concepts and facts: How can you explain that a tank of helium can fill hundreds of balloons? Why do scuba divers need to ascend slowly to avoid the bends? As the students look for answers they will eventually come to Boyle's law and when they understand the facts the conclusion can only be logical. There is no need for memorization.

> Let me tell you how I approach the laws of thermodynamics with my classes today.

I start by making them curious, by making them wonder. One great way to do this is by bringing in a cold pack from a first aid kit. It looks like a plastic package with chemicals inside and has, although we cannot see it, a barrier that keeps a solid and a liquid apart. When we twist or bend the package, the barrier breaks and this starts a chemical reaction that makes the package very cold.

I like to pass one of these around the class. The students can feel it cooling off as it goes from hand to hand. Then, I ask them questions such as: What type of chemical reaction do we have? Does the dissolving of this chemical release heat or absorb heat? From where is this heat absorbed? Where is the heat going? What are the surroundings? When we place the cold pack on an injured part, how does this part feel in terms of temperature? From where does the chemical get the heat to dissolve? By asking these questions, I can introduce the terms related to energy transfers. I can then ask the students to design a lab to measure the heat transferred during this reaction. They can compare this value with the heat of other reactions. With this exercise, I am adapting the content of the course to the real world of the students. This shows them the relevance of what they are learning.

Chemistry teachers reading this will see that these basic questions lead to two other concepts, enthalpy and entropy. Rather than beginning with a lecture explaining the laws of thermodynamics that explain these, I make students curious about some related phenomena from their lives. One of my favourite ploys is to ask them, Have you ever considered why your shoelaces can come untied but that they never spontaneously tie themselves?

A little less seriously, I also ask them, Have you ever noticed that when you undress your natural tendency is to throw your clothes on the floor? What would happen if you just kept doing this and no one ever asked you to clean up your room?

When I ask students questions such as these, they quickly get an idea of where I am headed, but I do not spoon feed them the theory. I am leading them to phrase the conclusion. Eventually, we reach an understanding of the natural tendency of everything on

earth to reach minimum energy and maximum disorder — in other words, things in nature tend to reach a state of minimum enthalpy and maximum entropy. Now the students understand why after all natural disasters, such as floods, volcanic eruptions or storms, things look messier and never neater. So by not cleaning their rooms, the students are simply aligning themselves with the laws of nature.

By coming up with such examples I can get the students to understand what drives chemical reactions, such as the one in the cold pack. We can then go a step further and talk about spontaneous and non-spontaneous reactions, and the effect of temperature on these reactions.

Concepts, Rules and Exceptions

The idea is to begin each topic with materials and processes known to the student, but not necessarily understood, scientifically speaking. It is a rather long journey from a cold pack to the laws of thermodynamics. A simpler concept, such as the effect of heat on the solubility of solids and gases, will give a better idea of the whole process. Most Grade 8 students know that sugar will dissolve faster in hot tea than in ice water. From there they might simply conclude that everything dissolves faster with heat. Follow this principle and you will be right most of the time, but there are exceptions.

I follow up the discussion about temperatures and solubility by asking students to write a hypothesis about what happens to the molecules that makes them dissolve faster as the temperature increases. Then I ask if this principle would apply to gases. A few years ago, during a hot summer, thousands of fish were found dead on the shores of Long Island. Can the previous hypothesis explain this observation? What are the solvent and the solute here?

I then ask, if heat makes things dissolve faster, why was there less oxygen dissolved in the water when it got really hot? Heat has the same effect on gas molecules as it does on solids, so what explains the different results? Once again, questioning, observing and analysing will bring us to the conclusion that, unlike for solids, the solubility of gases decreases with temperature.

From this discussion I get the students to come up with a hypothesis on this subject that they can test in a lab. We then move on to read solubility graphs and solve related problems.

I don't want to give the impression that my students always figure out the solution to the questions I pose about matters such as the fish kill or shoelaces that don't tie themselves. As a teacher I must engage the students in this inquiry-based learning, which is time-consuming, particularly at the beginning. To do so, one should:

- start the topic with examples to which the student can relate or with hands-on activities, rather than a lecture
- ask thought-provoking questions: a good question should prompt the students to fully participate in the class discussion by sharing ideas
- sequence the questions logically
- adapt the questioning to the grade level
- get feedback on the students' previous knowledge by the responses they give
- give the students projects they can relate to.

To come back to the case of Boyle's Law for a moment... When I teach it using this new method my students' first reaction is to ask why Boyle gets the credit for thinking of something so obvious. Of course it wasn't obvious to anyone before Boyle figured it out but what is important is that it is obvious to someone who understands the concepts.

Communicating and Understanding the Results

Communicating results is another important step. You don't understand something until you can explain it clearly to someone else.

One of the tricks I teach students is to pass their written labs along to a fellow student who didn't do the lab. I tell them that if their classmate can't figure out what is going on from the write-up, they have not written it well enough. The students must present the hypothesis, procedure, data (tables and graphs) and conclusion clearly and neatly.

As with generations of teachers before me, I make the students do problems to see if they have the concepts down, but I discourage them from simply plugging numbers into equations. Often I will ask them simply in what direction the numbers will go. If they have the concept they will always be able to say if the result will be larger or smaller. If they are obviously just guessing, then they haven't got it yet. The same is true for units: I ask them to do a unit analysis before giving me a number answer.

Another way to reinforce a concept is by using technology. I am a great believer in "wet" labs. I think that if you haven't spilled acid, broken a beaker or stained a bench, you haven't done chemistry. Because of this I always begin with real labs. Once that stage is finished, however, I think that computerized labs are a great way to make sure students understand the concepts.

These electronic labs differ from the real kind in that there is no experimental error nor clean up. That makes it possible to try a whole set of situations very quickly. I can manipulate variables I can't access in the "real" lab. Before entering the variables into the program I ask students to anticipate what will happen. Again it is easy to see when they understand and when they do not.

One last point that I would like to make is the importance of encouraging students to participate in science fairs, essay competitions and special projects. The important thing to remember is that, in the end, the only people who fail are those who do not try. There is much to gain from these events in terms of preparing and presenting your work, sharing ideas with other people in the field and making contacts. If I hadn't encouraged my students to send a proposal for the Canadian Space Agency's Canadian Protein Crystalization Experiment, we would have missed the excitement of witnessing the launch of the space shuttle *Atlantis* with our experiment on board.

The old scientific method meant to formulate a hypothesis, do extensive experimentation and accumulate data. The new scientific method means to formulate a hypothesis, patent it and raise $10 million. I consider this reality when preparing my students.

When they leave my classes, they will be faced with a barrage of scientific claims from such diverse groups as advertisers hawking new kinds of shampoo to environmental groups looking for money. Even if the students haven't memorized the science related to these claims, they will use their critical thinking and problem-solving skills to begin evaluating the claims' relative merits and make their own judgement.

From facts and understanding comes knowledge. It is important to equip the students with the skills necessary to evaluate what goes on around them and to show them the relevance of what they are learning to their lives.

BUILDING PASSION FOR LEARNING

RICHARD FORD
CREATIVE INQUIRY CENTRE
WILLIAM LYON MACKENZIE COLLEGIATE INSTITUTE
NORTH YORK, ONTARIO

The Creative Inquiry Centre at William Lyon Mackenzie Collegiate Institute in North York is where you will find Richard Ford creating a new style of education. Instead of teaching in the conventional sense, he encourages students to discover for themselves what they can do, and how to do it. He coaches, suggests and facilitates. He continuously extends the limits of education, pioneering new partnerships between business, government and students.

Under his guidance, students participated in the recent G-7 conference in Halifax by video conference, created the Metro Hazardous Waste Materials instructional video, and ran a multimedia conference by and for students.

Mr. Ford's teaching style fosters cooperative and self-directed learning, essential in the fast-changing technological environment. Student achievement is remarkable. Even classes with students speaking many mother tongues work together to produce professional quality materials for outside clients.

Richard Ford believes that his role as a teacher is to create interest and desire for learning — what he calls passion — in students, and invokes this through group mentoring. He puts the students in charge of their own learning, teaches them to consider unconventional sources and solutions, and leads them to success.

With passion, students can do and learn anything they want. In the Creative Inquiry Centre at William Lyon Mackenzie Collegiate Institute (an interdisciplinary resource space of computers and other equipment), students find innumerable opportunities to pursue their passion while he ensures that they meet and exceed curriculum outcomes and expectations.

Mr. Ford is currently on a leave of absence from the North York school board in Ontario. He is a co-founder of KidsNRG Inc. (**http://www.kidsnrg.com**), a problem-solving company specializing in youth development. He can be contacted at **richard@kidsnrg.com**

THE IMPORTANCE OF MENTORS

All the successful people I have ever known have had a mentor at some point in their life, someone who taught them and encouraged them to take risks with new experiences. I owe a great deal to the mentors in my life. So, instead of simply teaching information, I concentrate on being a mentor to my students, and training them to be mentors to each other, creating what I call mentor groups. I use just one basic principle: I never do anything for the students that they could do for themselves. I cannot give them passion, and I do not give them any answers. They must find passion and answers themselves.

A KidsNRG (the company I co-founded) team, whose members were already mentoring each other, was once asked to create a mission statement for the school of the future, in two days. At first, they had no idea how to approach the problem. Did the client want them to foresee the future, or say what they wished the future would bring? After hours of discussion, the group decided that they could not answer with a closed-ended mission statement. Instead, their presentation took the form of five questions.

- What do you want?
- What do you have?
- What do you need?
- Where are you going to get it?
- What will you do with it?

I find this list of questions to be both profound and applicable to many other projects. I now use these questions as a guide when creating a mentor group.

What do you want?

What someone wants is a good indicator of who they are as an individual. We work to get what we want. Where we work, what we study in order to do that work, who we work with, and what we think about, all create and change our personality.

This is where creating passion comes in. It is the passion to get what you want, and to learn and create that motivates people. This is my expertise. In the Creative Inquiry Centre I help the students figure out what they want badly enough to work hard for it. I ask big, open-ended questions such as, What project are you interested in? What do you want to do with it? What do you want to learn? I give them permission to talk about themselves, and I really listen.

By finding out what the students want to do, and then supporting them in every way possible, I facilitate their own learning process. I ask questions to help them find out what they want to do. I encourage them to explore for themselves ways to get what they want. I help them figure out what they want to learn. As I see it, a teacher should transfer responsibility for what has to be learned to the students, because when the students take on the responsibility, they will go beyond what anyone expects.

Some of what they want may not seem important, but every goal works towards developing passion in learning. Do you want to do it on time? Do you want to be more organized? Do you want to learn something in particular?

What do you have?

In order to be mentors to each other, group members need to develop trust and a common pool of knowledge. An initial discussion about what they want, and what they like doing helps everyone get to know their group mates, and to know each other's strengths and skills. Then they can begin to determine what they have within the group itself and work together.

On the first day of an Emerging Technologies Program class — a computer class for students with little previous exposure to computers who are unlikely to pursue higher education — I explained to the students that the first project was for each of them to design a Web page by the end of the week. One girl asked, "What's a Web page?" and I shrugged and said, "I don't know." (I really do not make anything easy for them.) Then I asked the class, "Who knows anything about Web pages?" and six students put up their hand. I suggested that the rest of the class remember those faces, because for this project they were the experts. I turned to leave the room. "Oh, by the way, one last thing," I said. "If everyone doesn't present a Web page with text, a graphic and a link, then everyone gets zero."

By the second day, some of the students were going around asking others if they needed help. They had to learn to cooperate because there were only 15 computers for 30 students. They also had to learn to communicate and solve problems because there were 15 different mother tongues in the class. They had to take responsibility for their own learning and for the success of the entire group.

What do you need?

An important step in any project is determining the gap between the resources and information you already have and those that you need to complete the project. In the case of the Emerging Technologies Program students, when they had exhausted every resource they had and still could not find a solution to a problem, I allowed them to come to me for assistance. By the end of the week, they had all found what they needed to create a Web page (with very little help from me).

The next step was to present their Web pages to the class. One boy from Sri Lanka who spoke very little English hid at the back because he was too shy to go in front of the class. I coaxed him to the front, and he mustered up the courage to say, "My Web page... first time... graphics... see link. Thank you." All the other students applauded. Everyone knew what an accomplishment it was for this boy to speak in front of everyone else. Later, he told me, "I am proud."

By developing mentor groups I can accommodate different learning styles and abilities. The self-directed learners take off at their own pace, once I have given them a start. The ones that need a little or a lot of coaching get what they need because I have time to give it. I just move from group to group as the students work, judging the emotional tone and giving encouragement or guidance as it is required.

Where are you going to get it?

The key to a mentor group is that everyone helps to complete a project, whether it's designing a Web page or hosting a large conference. Often, the information is there in the group. By asking and learning from each other, the students develop trust and confidence in the group and in themselves that is invaluable. With this confidence, they find it easier to admit that they don't know all the answers, and easier to approach other sources outside the group for help. This gives them great self-assurance and leads them to try an even bigger project next time. Every time they take on a new challenge, they learn something about the world and about themselves.

Elementary and high school courses have guidelines. These guidelines, or curriculum objectives, are broken down into problems, which are then presented to the students as a way of teaching them the curriculum. Sometimes, students are interested in solving the problem the way it is presented. Other times they are not, and that's when they become bored. My job as a facilitator is to find the problem that the students want to solve. It will still satisfy the curriculum objectives, but the students will be interested and passionate about it; they will want to work on it and they will learn.

Project management, organization, graphic design, scheduling, deadlines, information and technical support — these are all things that the students need at one point or another. As I see it, when they

know what they need, they will find the answers. This is why I call myself a facilitator rather than a teacher, because I do not think I need to "teach" anything. When the students want to know, they'll teach themselves. If anything, I encourage them to want to know.

What will you do with it?

After the first week in the Emerging Technologies Program, when they designed their first Web page, the students launched into Web design for real clients. They learned about this new media — the Internet — on the job. They developed language and presentation skills, they learned how to interact with clients and meet deadlines, but most important they learned how to share expertise and how to find what they needed. They learned to be mentors and find mentors.

One group built the Canadian Broadcasting Corporation's movie Web site. IBM hired a group to create a CD-ROM about a student-created conference called Minds Meeting Media that brought together 1990 kids from across Toronto to present animation and multimedia projects.

Every time the students met a client or made a presentation of a completed project, they were performing. Performance changes you. It is one of the milestones of life that I think everyone should experience. Practice is fine, but actually getting up and demonstrating what you have learned, be it a piano concerto or your own first Web site, is a life-changing experience. The more performance opportunities we create for the students, the more we help them find what they want, the more they will change, grow and take responsibility for their own lives.

À LA "CART": COMPUTERS IN THE SCIENCE LAB

BOB SANDERS
SIR WILFRID LAURIER
COLLEGIATE INSTITUTE
SCARBOROUGH, ONTARIO

Chemistry Department Head Bob Sanders of Sir Wilfrid Laurier Collegiate Institute — a 33-year-old high school in Scarborough — is a firm believer in the value of hands-on learning. The school is a microcosm of the challenges of multiculturalism. Of its 1300 students, one third were born outside Canada. Gaps in these students' education caused by disruptions in their home countries, as well as language difficulties, present special challenges to teachers.

Mr. Sanders uses "kitchen chemistry" to hook students' interest while teaching theory, and plenty of lab work to hold their interest and suit different learning styles and abilities. His high standards and expectations result in students being well prepared for university and community college courses.

A tireless organizer and contributor to professional development, he is a pioneer in integrating computer technology into every level of the science curriculum, using CD-ROMs, dissection simulations, and other software in exciting and creative ways. These computer programs supplement the classroom and lab lessons, providing a wider range of experience than the equipment and budget available would otherwise allow. Increased enrolment in science classes, the enthusiasm of students and the calibre of their work all attest to Mr. Sanders' teaching excellence.

Bob Sanders loves science and loves working with students. Recognizing that hands-on lab work catches learners' interest, he makes extensive use of investigative science projects to teach basic scientific knowledge and instil a love of the subject.

About 10 years ago, he realized developments in computer technology held great potential for science teachers. Computers allow for exciting learning situations that would otherwise be too expensive and time-consuming to set up in an ordinary high school. His innovative mobile computer carts are an affordable, practical tool for integrating technology into any school and curriculum.

ROLLING IN NEW TECHNOLOGY

I would describe myself as a traditional teacher, one who tries to find a balance between hands-on teaching and hands-on learning. Both have their place in my classroom, but I tend to move as the semester progresses from teacher-directed lessons, using lectures and traditional tools such as the blackboard, overheads and audio-visual aids, to teacher-assisted lessons, when I act as a resource to the students' learning.

I aim for the same progression from traditional lab activities to those using newer technologies. Standard lab work gets a class started on a topic, but lab interface technology that uses probes to collect data values, reaction animations that let students construct molecules on the screen, along with other software allow the students to concentrate on the investigative science quickly and easily.

There are a couple of factors to consider when bringing computers into the science lab. The first is cost and budgeting.

In 1992, we decided as a department to devote a large portion (40 percent) of our budget to acquiring new technologies for the classroom rather than buying textbooks. Computers do not take the place of textbooks; students still need print materials to provide them with a knowledge base, a ready resource to follow up on activities in the class. Nevertheless, we decided to keep using the textbooks we already had in order to get some new technology into our classrooms.

With this new emphasis on technology in mind, about four years ago we visited a local school that was being rebuilt. The Science Department Head there was taking advantage of the opportunity to incorporate computers into two of the new science labs, to create the kind of environment that would encourage collaborative learning. He planned to have eight computer stations, one at each laboratory bench, for groups of three or four students to work on together.

This set-up was obviously going to be quite expensive. My colleagues and I quickly realized that we could not duplicate it at our school, so we came up with the idea of mobile computer carts as the next best thing. It has proved to be a very affordable alternative to full-scale computer rooms that still brings the benefits of integrating computer technologies and scientific education software into the curriculum. We started with just one computer station on a movable cart in 1994 and now have eight.

Each workstation consists of a standing-height cart with a Macintosh LC575 and a Vernier lab interface that accepts data such as temperature, pH, or pressure from lab probes and translates them into a digital form for the computer. The school bought the machines second-hand from CPUsed in Toronto, which sells used Macintosh computers and peripherals. (A sister company, PCUsed, handles used PC-platform computers.) We purchased the second-hand LC575s for a few reasons:

- Scarborough schools have had the more "user-friendly" Macs since the mid-1980s when the complexities of DOS-based machines restricted their use to trained teachers and students in computer classes. Even with the advent of Windows, the Macintosh platform continues to provide a more stable environment, requiring less specialized knowledge to install and set up software, and one that is far less susceptible to computer viruses and system crashes.

- The Macintosh LC575 is an all-in-one unit, with the monitor integrated with the CPU. In our mobile situation, the fewer pieces on a cart, the better!
- The 68040 processor was the workhorse of the Macintosh family in the early 90s (similar to the 486 in the PC world). Almost all software we previewed was available in both Windows and Mac format. Currently most science software comes on hybrid CD-ROMs. Some recent releases of software requiring the Mac PowerPC processor (similar to the Pentium) are incompatible with our LC575s.

Security cables fasten the equipment to the carts so teachers can safely wheel them from room to room. The keyboard is on a pull-out shelf set a few inches higher than the lab benches. For some students, it is a little too high for comfortable typing, but keeps the keyboard above most laboratory spills. Four of the carts also carry ink-jet printers and A-B switch boxes with six-metre printer cables to connect to a printer-less cart for printing. It is a primitive network, but it works. (An added benefit of this system is that it requires the students to coordinate their printing jobs.)

Teachers sign out the carts and move them from class to class just like the TV/VCR carts. They may sign out one computer at time, or two, three, or even all eight, depending on their needs.

THE COST (AS OF 1996) OF EACH OF OUR EIGHT MOBILE STATIONS BREAKS DOWN AS FOLLOWS:

Macintosh LC575 (used)	$1200
Standing height cart	$200
Vernier lab interface	$500
Shared printer	$200
Shared software	$750
Laboratory probes	$500
Total per station	**$3350**
Total for eight stations	**$26 800**

We maintain that a full-scale computer room of 24 to 28 computers is not appropriate for science. (Comparable cost would be $75 000 to $90 000.) The computer is a tool to be used in the science lab. Relegating them to a separate facility prohibits student use of the technology as a companion to their science lab work. Eight stations is not a magic number, but we have found it promotes student group work in the laboratory for class sizes of 24 to 32 students. Also, since our science labs are up to 30 years old,

they are not large enough to accommodate additional computer carts without them becoming a safety hazard.

We could have installed these computers on existing lab benches in one of our eight labs, and rotated our 50 science classes through on a room exchange basis. We decided on the mobile computer option for several reasons.

- A special lab would again elevate the status of the computer beyond that of just another lab tool in the eyes of the students.
- Displacing classes from any room is inconvenient.
- No more than one class could use computers at a time and some activities need only one, two or three computers in the lab at a time.
- Bringing the technology to each of the labs provides more flexibility and opportunities for spontaneous use than would a formal sign-up in a special room.

This brings me to the second consideration of integrating computers into science labs. Most schools fortunate enough to have full computer rooms tend to reserve them for computer and business courses, in which the computer itself is the lesson. They run standard, easily obtained business, word-processing or spreadsheet programs. In science and other areas, the computer is not the lesson. Consequently, the market for educational scientific software is small, and fewer software companies invest the time and money to create these programs. In addition, few teachers know how to make the best use of these programs in a science course because, along with the scarcity of the programs, there is limited access to training.

The programs are expensive. With our limited budget, I cannot really afford to make a purchasing mistake. We have found Tangent Scientific in St. Catharines, Ontario, to be a good supplier of a wide range of educational scientific software in all fields of science — biology, chemistry and physics — offering excellent customer support. Tangent's library of available titles has expanded quite dramatically over the past few years, and prices have been dropping as the market for science software expands. All the titles I have previewed from them are very good quality. You can reach Tangent by phone (1-800-363-2908) or by E-mail (**sales@tangentscientific.com**).
You may also wish to visit the firm's Web site (**http://www.tangentscientific.com**). When I do find a piece of software that I think would be useful, I ask for an evaluation copy and try it out. My colleagues who teach physics and biology play around with the programs too. If it seems to be something we can use, we usually just buy one copy at first, install it on one computer and use it to design an independent study project — Grade 12 and OAC (Ontario Academic Credit) semester-long research projects.

For example, the project might call for the students to investigate an organic chemical reaction. The students could create the molecules with a modelling program, showing all the chemical bonds in the correct orientation, and then animate the reaction using slide show software. Next, they could research everyday uses of the compounds, and then put it all together into a presentation either on paper or on video.

We buy more copies of the programs that pass this informal testing process. This allows us to install the program on additional computers. At the beginning, we installed only the most heavily used programs on all eight machines because of the high cost of site licences.

As a result, each of our workstations had a different combination of programs. In some cases, we had only single copies for independent study use. For other titles we may have had four. Over the years, though, we gradually expanded the licensing so that now most of the software is common to all computer stations. To help everyone remember which computers have which programs, the machines are colour-coded. Each Mac has a 10-cm-wide, colour vinyl sticker on each side, and a smaller one on the front so that people can identify it from any angle. The desktop screens are also customized to the same colour. Our colour scheme is white, red, orange, yellow, green, blue, violet and black, a modified version of the colours in the spectrum. Teachers are aware of the programs available on each Mac by colour.

The computers are not networked to a central server, but are instead stand-alone computers with their own hard drives. Some experimental work occurs over several lab periods, and students store their work in progress on a computer. They then need to work with the same machine in subsequent periods, so the colour coding really helps here. The spectrum sequence also helps students and teachers put the Macs at the correct lab station as they move them around from room to room.

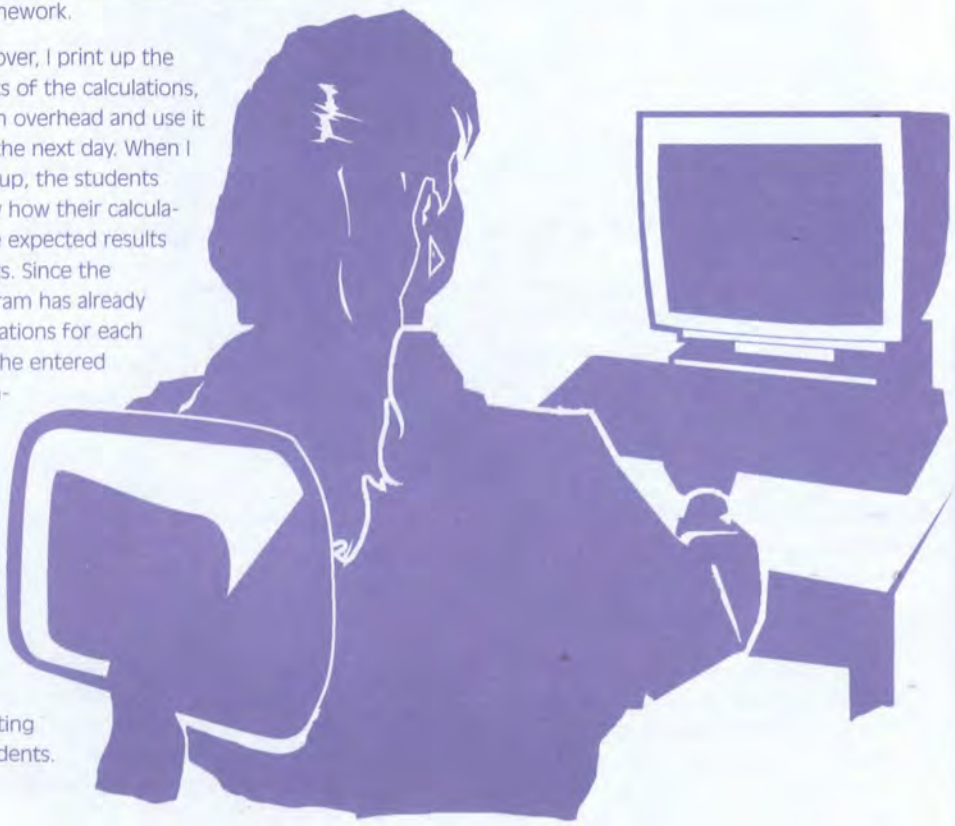
Getting Rolling

Even a single cart helps immeasurably in a science class. For example, if the students are doing an experiment involving quantitative lab work and collecting data values, we use a single computer and a spreadsheet program. As each experiment finishes, the students enter their results into the spreadsheet. The spreadsheet program quickly does the relevant calculations in the background (unseen by the students). The students later work out the same calculations themselves as their homework.

When the class is over, I print up the spreadsheet results of the calculations, make them into an overhead and use it to teach a lesson the next day. When I put the overhead up, the students can see right away how their calculations matched the expected results of the experiments. Since the spreadsheet program has already done all the calculations for each student as he or she entered the data, I can simply check the results instead of systematically checking each student's calculations. This saves marking time and gives me more time to do hands-on, interesting work with my students.

Physics students can use a computer to run simulations with slight changes in the variables each time. Biology students can set the computers to monitor plant metabolism experiments while the class is doing something else. Chemistry students can create and animate chemical reactions on screen. Only knowledge and the availability of software limit the possibilities for activities and learning.

After four years, it is clear the mobile computer carts are a success. The school now has extensive integration of computer technology into the course curriculum, and the carts are always in demand. And, as it's turning out, the computers and software were probably a better investment than textbooks would have been since we can easily adapt them to any new curriculum requirements. Our students spend more time in each class doing hands-on experiments, investigating scientific principles and phenomena for themselves and really learning.



Independent Study Projects with a Difference

When I design an independent study project for my chemistry classes, I offer the students a number of different project formats. This gives students of different learning abilities and styles the opportunity to show me what they have learned in their own way. Each project explores similar content and processes, but the students have a choice of how they present their work.

Here are some of the presentation choices I have given my students over the years:

Molecular Model and Fact Sheet: build a 3-D molecular model from materials of your choice. Write a fact sheet (not a mini-essay) to outline the properties and uses of a chemical.

Chemistry Board Game: create a board game to review a chemistry topic. Prepare an instruction page and a reference sheet for the chemistry involved.

Your Own Periodic Table: design a periodic table organizing items other than elements. Show at least four periodic trends. Provide an information sheet to relate the periodic patterns to the real periodic table.

A Chemical Autobiography: write the autobiography of a substance, describing its properties as anthropomorphic qualities. A mystery with clues or a children's story with pictures are possibilities.

Applications Poster and Fact Sheet: illustrate a chemical concept or industrial process in an original way. Prepare a fact sheet in non-essay style to outline the uses and implications for daily life.

ILLUSTRATING THE LESSON

PAT BELL

CENTENNIAL COLLEGIATE VOCATIONAL INSTITUTE
GUELPH, ONTARIO

Writer, editor, presenter, teacher and teacher of teachers, Pat Bell is known throughout her school, the province, the country and internationally for efforts in the teaching of Latin. Her teaching awards and scholarships testify to her international status among educators. Ms. Bell is that rarity who combines serious scholarship, imaginative ideas and loving attitudes in one person. She gives her students knowledge, understanding and compassion, challenging them to expand their horizons and try their talents in new areas. She has earned the greatest respect of her peers and the love of her students and their parents.

Ms. Bell spends many hours supervising preparations for the Ontario Student Classics Conference, a provincial athletic, academic and creative Latin competition. Her well-organized and informative biannual Classical Tour of Italy is in high demand both at Centennial Collegiate Vocational Institute and among other Ontario Latin teachers. The effects of her efforts pervade the school, as her students choose classical themes for French class presentations, English creative writing, artwork and architectural drafting.

It only takes a visitor to Pat Bell's Latin classroom a few minutes to recognize that she does not just teach Latin; she completely immerses students in the study of Roman history, culture and language. The room, where she has taught Latin for half of her 30-year career, is overflowing with murals, dioramas, mosaics, architectural structures, reproductions of clothing, jewellery and depictions of Roman mythology, all created by students. A sign on her classroom wall reads "Latin is more than a language." All this activity has its origins in an illustrative teaching method she calls the Pictogram Approach.

In addition to her classroom activity, Ms. Bell contributes towards the teaching of Latin across North America. She was a member of the Ministry of Education writing team for the Ontario Latin curriculum guidelines, has written two Latin literature textbooks, and teaches pedagogy to Latin teachers during the summer. She is a founding member and Publications Officer of the North American Cambridge Classics Project.

DRAWING ON LATIN

I never had any doubt about my vocation. When I was five, I had all the neighbourhood children lined up on the curb, while I was teacher. I love being a teacher!

Centennial is a public collegiate vocational high school. Our school population ranges from 1300 to 1400 students. Since Latin is an optional subject and an intimidating one, I walk the tightrope of maintaining academic rigour while enticing students to choose the Latin option.

I teach to instil in my students a joy of learning and a habit of curiosity. This not only ensures they will succeed in their current studies but also creates a lifelong love of learning. I direct all my teaching practices to this end. I want my students to come eagerly to class, asking, "What are we doing today?" Latin just happens to be the vehicle I use.

I think Latin is the ultimate interdisciplinary subject. Since much of the English language derives from Latin, the study of Latin touches language arts, everything from vocabulary and grammar to literary style. It is also the study of our history, shaped as it is by Roman

history. Geography, textiles, clothing styles, medicine, science, law, civil engineering, military history and many more subjects are easily drawn into a inter-disciplinary study of Latin.

Pedagogical research stresses that variety in teaching strategy is crucial to accommodate all learning styles. On a more immediate level, since Latin is an optional subject, my classes attract students of all academic abilities. I teach in long (73 minutes) periods. To meet these pedagogical and practical demands, I have created a lot of variety in my program.

The Pictogram Approach is one of the many techniques I use to bring variety to the class. I have developed this approach over the years and refined it with the help of my students. It is an illustrated approach to reading, a way to focus on language comprehension, rather than word-for-word translation. It serves as a means to enhance the written and aural/oral with the visual.

A PICTOGRAM IS WORTH A THOUSAND WORDS

An early pictogram lesson introduces the students to simple Latin text, and shows them how to begin translating and comprehending it. The lesson also shows the students that the study of Latin is going to be much more than simply translating words.

I start with three short sentences in Latin on an overhead acetate. For this first lesson, the sentences stand alone. Later the students learn that they are the

beginning of a story. The sentences express three simple ideas: A friend comes to the house. The friend is visiting Caecilius. He is a merchant.

The students and I do not translate these sentences word for word. Rather I elicit from the class, by using the English derivatives of the Latin words, first what the sentences mean and then, from the context clues, the scene they describe. They usually figure out quite quickly that "mercator" means merchant, so I ask them, What status is the merchant, slave or free? From the status of the merchant, we figure out what he would be wearing.

In a similar way, I help the students figure out the details of the setting. What does the street look like? How do pedestrians cross the muddy streets? Where was a Roman garden? As they answer each question I add details to the picture on the acetate and gradually fill in the background around the merchant. (No artistic talent is necessary. I am a "stick figure artist." My drawings do not inhibit my students, but encourage them to surpass me.) The virtue of the overhead projector is that all eyes focus on the same item at the same time, mistakes erase easily, and coloured pens make the drawing visually interesting. All of the information, everything that makes these sentences come alive for the students, is there in the contextual clues.

I draw everything the class can suggest on this first picture to show them the detail of illustration and therefore the level of comprehension and accuracy of detail and research I expect. Then I give them the rest of the story that goes with the initial three sentences. They read the rest of the story and draw four more frames to illustrate it. As they read the story, they find that the men enter the atrium, the study, the dining room and finally the kitchen. In the five scenes from this Latin story, the students construct in detail the Roman house as well as the plot and interaction of the characters.

After the initial demonstration, I use the Pictogram Approach in a variety of ways. Sometimes, I have the pictures already drawn on a worksheet. The students have to read the Latin story in their textbook and rearrange my drawings in the right order to show the progress of the story. Other times, I just give them captions, and they have to draw pictures to match. Alternatively, they may draw large murals in groups. They develop a comfort and familiarity with the language in its cultural context as they go along. With other stories we will use a more traditional translation approach. The Pictogram Approach is not a replacement for careful word-for-word translation; it is an adjunct to it for variety in teaching strategies.

I try to maintain diversity even in the contexts in which I use the pictograms. Sometimes I include it in a teacher-directed class, sometimes in a student-directed situation. I use the approach for consolidation and review, for summarizing a lengthy story, or illustrating a complicated sequence of events. In the third and final course of high school Latin, the students teach seminars on Latin poetry. Many of them choose pictograms to illustrate the poetic devices in the poems. The possibilities are as vast as the imaginative creativity of the students.

My colleagues tell me that my Latin students have introduced pictograms in other courses to illustrate and explain a variety of concepts. French, German or Spanish teachers could use the Pictogram Approach exactly as I describe it. English literature teachers could use the method as part of an in-depth study of a period or particular author. Environmental studies, social studies and ecology instructors, who need to take a wide range of related factors into account when teaching a concept or scientific principle, could make use of the method to illustrate and explain these interrelated factors in a fresh and interesting way.

With an approach like this, the students are engaged in effective multidisciplinary learning. They are working with so many aspects of study at once that this method teaches them flexibility of thought. On a pedagogical level it works extremely well, mostly because the students have a lot of fun with it. In my Latin course, when students explore culture as well as language by hearing, seeing and doing, they learn more than the bare mechanics of the language. They gain a love for the subject and for learning.

The Ontario Student Classics Conference

This conference is held annually on a university campus the second weekend in May.

The competitions, which are part of the conference and in which more than 600 Ontario Latin students take part, have three elements. The athletic component includes foot and chariot racing, swimming and slinging. The academic section tests students' knowledge of Latin vocabulary, derivatives, Roman and Greek history, mythology, Roman life and translation. The creative section features an archaeological dig, fashion show, school display, projects and a stage play.

Our school's Latin Club, the Dead Poets' Society, sends 35 to 45 members to the competition every year. Preparation begins in September: teams design and build a new chariot each year in accordance with the year's theme, make authentic ancient costumes, and write a narrative script or write and rehearse a stage play. Some students write computer programs and build models.

Other teams research and create appropriate artifacts for an assigned archaeological dig site.

When they arrive at the conference, the students "plant" their artifacts in a simulated site. The next day, they excavate another school's site, and attempt to identify the site's "location" by the artifacts they find.

The entire group works on assembling the year's club scrapbook, planning the school's display and, of course, studying for the academic contests.

The conference venue changes every two years. Recently we have been to Queen's University in Kingston and Brock University in St. Catharines, and next year we will gather at the University of Guelph. Besides supervising the students in their preparations, many Latin teachers from around the province meet regularly on Saturdays to prepare the contests, organize the events and the judging, assign rooming and take care of a myriad of other details.

CHALLENGING KIDS WITH COMPETITION

DANIEL THORSLEY
G. A. WHEABLE CENTRE FOR ADULT EDUCATION
LONDON, ONTARIO

Daniel Thorsley of the G. A. Wheable Centre for Adult Education in London is a dynamic and captivating teacher of science, chemistry and physics. He has the ability to interact well with students of all ages.

Eager to create learning experiences for all students, Mr. Thorsley employs as many ways as possible to have students see the knowledge and skills they are learning in a different way. For example, he makes use of discrepant events — an experiment in which common sense predicts one outcome but the activity produces another. For the same reason, he develops curriculum-based contests in the London area. He has been involved in the local science fair for more than 20 years and in the London Science Olympics for almost as long.

Mr. Thorsley is a leader in science education in the London area. He writes computer programs to illustrate chemistry and physics concepts. He has computerized the registration and attendance procedures required for adult education. He publishes a newsletter called *SCIENCE2000* to keep schools and community leaders up to date on what is happening in science in London. He is chair of the committee that will host the Canada-wide Science Fair in London in the year 2000.

In his 28 years of teaching, Daniel Thorsley has developed a special touch for contests. He believes they are excellent tools for extending the curriculum, a point that is crucial for him. His contests are not extracurricular activities, although they may take place outside the classroom.

Mr. Thorsley doesn't confine his efforts to his own students. Over the years, he has developed a wide variety of competitions covering different science subjects and age groups for students from all over London, Ontario, and thanks to the Internet, in schools elsewhere with similar science curricula. He believes that teachers should make more use of contests and that anyone can learn how to create effective and inexpensive contests to enhance the science curriculum.

Below he shares some of his ideas for creating successful competitions, along with examples from two of his best efforts.

DEVELOPING CONTESTS THAT STUDENTS AND TEACHERS WILL LOVE

I have always loved contests and, more importantly, so have my students. Some teachers and parents have reservations about competition between students but kids don't; they enjoy contests because they can do something with what they have learned.

People who have reservations about competition worry about the negative effects on those who do not win. My response? Competition is a normal part of life. We all compete constantly throughout our lives and we have to learn how to win and lose. Competing is one of the generic skills that we must master to "compete" successfully in our society. A badly designed contest can have negative effects but a well-planned one teaches kids how to deal with life's challenges and how to learn from the experience so they can improve their performance next time.

Opportunities to create contests arise regularly; I have never had to go looking for them, and once you get known as someone who is capable of putting an effective competition together, other enthusiasts will come looking for you. One of my competitions (more about this below) came about after our local power company, London Hydro, and the school board combined forces to produce a new curriculum about the use of electricity in the home. The utility expressed interest in having a competition to cap off the program.

At the risk of being repetitive, I believe that effective contests must be connected to the curriculum. I can't stress this enough. A contest is simply normal curriculum activities taken a step further so that two (or more) groups can compare how well they have learned the content. (The advantages of setting up the competition so that just two teams compete at a time is that no one gets beaten by more than one team.)

I try to incorporate more than one kind of skill into my competitions. Some contests, such as spelling bees, require only one skill. Contests that use a whole variety of skills are more challenging and give students a number of opportunities to shine.

As I create and improve a contest, I try to avoid getting sidetracked by peripheral issues. For example, with science fairs it is easy to get too concerned about whether a student has done the work on his or her own or has gotten help from a parent. The real issue is not whether the student had help but whether he or she understands the material involved. An interview will quickly establish whether the student knows what he or she is talking about.

(The issue of getting help or not is a red herring in my opinion. It is common, after all, for teachers and university professors to help students with the design of their research and the methodology of their experiments. What is so different about a parent giving similar assistance? The positive benefits of parents and students working together on a project of mutual interest can be extremely valuable to the students' education.)

I pilot test each contest I create with a small group, often my own classes, and then improve it before launching it officially. I find that I have to improve contests continuously as students keep changing. Today's students have a completely different set of abilities and knowledge from that of students just five years ago.

The major barrier for teachers thinking of involving their classes in competitions is expense, and the biggest expense is having to take students outside the class. There are two ways to overcome this. In the past, I have usually timed my contests so that they coincided with other events such as science fairs. Lately, I have also been making extensive use of the Internet. In principle, an Internet-based contest can be open to anybody with access to the World Wide Web and E-mail for very little cost to the organizer

or the participants. Best of all, a teacher can have students do the contest right in class.

Timing is another important issue for teachers. If the competition only takes one period, it can run any time, but longer contests have to be timed to fit into a teacher's other responsibilities. Longer contests are best done in the spring because that allows teachers and students more time to prepare. If a school is on the semester system, the end of October or the end of April are the best contest times.

PRIZES

I like to see everyone who participates get something for their efforts, and with computers and printers it is easy and inexpensive to create nice certificates for all.

For the winners, I favour cash prizes that go to the school or class. Sometimes, especially when you have corporate sponsorship, you can offer larger prizes, such as scholarships, but these can create a different, and less desirable, feeling than smaller prizes that are shared. Many teachers are opposed to larger prizes for their classes because they change the emphasis from having fun with the knowledge and skills being used to winning the prize.

Trophies are also a good idea and they have the advantage of being reusable.

SOME EXAMPLES

One recent contest that went very well was the Cyber Challenge. It is especially easy to set up, and for students to participate in, because it uses the Internet. You simply advertise that you will put a set of science questions on the World Wide Web at a particular time and day. The participating classes put together teams with expertise in a number of scientific fields and answer the questions as quickly as possible. I send an answer form out by E-mail on request, and also ask the teacher to verify that the class did everything by the rules. (That said, in a simple contest like this, the chief pleasure comes from doing it right, so there is little incentive to cheat.)

I create three levels of competition, each of which has a separate set of questions. The junior level is for grades 4 to 6, intermediate for grades 7 to 10, and senior for grades 11 and above.

In addition to answering the questions, I ask each team to write, within 24 hours, an essay about some point of interaction between science and society. The team members may either work together or have one person produce the essay. Last year, the junior, intermediate and senior essays were about conservation, a specific pollution problem and the ethics of cloning, respectively.

If you are interested, I have posted all the recent questions, answers and essays (**http://quark.physics.uwo.ca/sfair/scifr.html**). (This Web page also includes lots of information about the local science fair, Science Olympics and the Canada-wide Science Fair.) All teachers and students are welcome to participate next year or they can adapt the idea to suit their own purposes and subject areas.

A variation on this contest is the Technology Cyber Challenge. I give teams of students a set of parameters that they have to respect while creating a machine to do a certain task. This year's machine had to propel a golf ball through the air. I also supply a list of the materials the students can use. (To be fair, I post this list at least a week before the actual contest so the teams can get everything they need.) I pick up the machines and a set of instructions the students have prepared on a specified day and test them. I later post the names of the winners on the Web.

A special challenge of this contest for the students is writing the instructions for the machine. For anyone who has struggled to follow the instructions that come with a new appliance, this is a chance to see the problem from the other side. It is a very important part of the contest because the machine cannot compete if the judge cannot figure out how to make it work.

The machines are judged not only on performance but also according to how well the students followed the rules. For example, a number of this year's machines were disqualified because the judge had to hold the mechanism in a particular way, making him or her part of the machine.

The Technology Cyber Challenge is more limited than the Cyber Challenge because the participating schools must be close enough for the judges to pick up the machines.

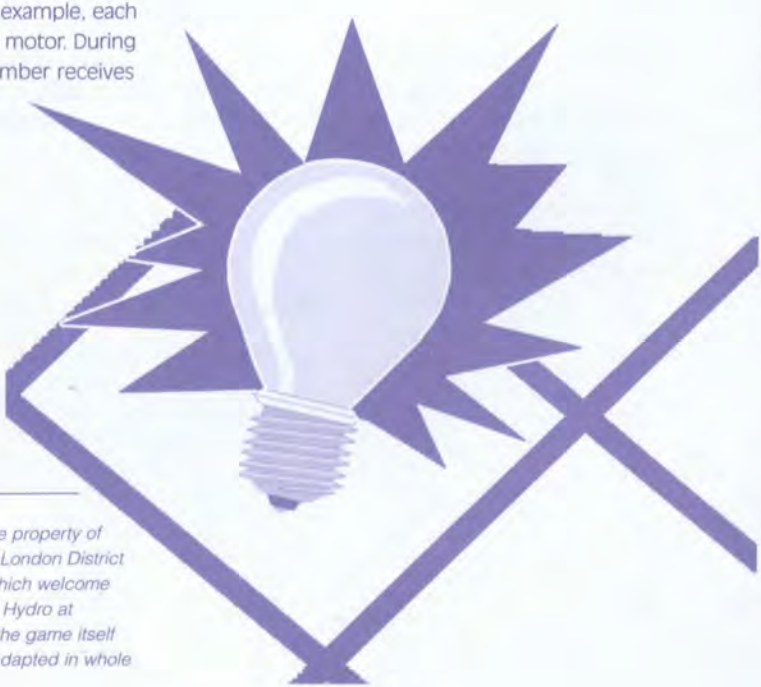
Current Capers* is the contest I mentioned earlier that I designed to extend a unit about electricity use in the home. The unit was for junior grades and, in it, students looked at how electricity is used at home, learned to read meters and built a motor.

I designed the four-part contest to run at the completion of the unit in conjunction with a local science fair. In the first part, the teams received pictures of hydro meters and had to read them quickly and accurately. In the second part, they had to estimate the cost of providing power for a particular home. Next, they were asked to build a working motor out of a D battery, a couple of paper clips, a foam cup and a coil of copper wire. Finally, they took part in a game of tick-tack-toe on a special electric board created for the contest.

The teams for this contest have an equal number of boys and girls and the competition is structured so the whole team has to contribute. For example, each team member has to build an individual motor. During the tick-tack-toe game, each team member receives a light bulb. When a player answers a question correctly, he or she gets to insert the bulb into a socket and turn it on. After that, the player cannot answer any more questions.

It's amazing how big a kick the kids get out of screwing in their light bulb and flipping the switch to turn it on. The tick-tack-toe board is 1.2 m^2 and has three rows of sockets with a switch for each socket. Each team has bulbs of a particular colour. The rules of the game are the same as for the paper version, except that students have to answer a question correctly to get their turn, which makes it much more challenging.

The effectiveness of a contest boils down to one key factor. The best competitions allow students to make the connection between knowledge and action. Many students get to be good at science without understanding technology, while others become experts in technology without understanding the science involved. Contests are a powerful incentive for students to make those connections.



**The curriculum unit Power of Electricity is the property of the Thames-Valley District School Board, the London District Catholic School Board and London Hydro, which welcome any inquiries about it. You can reach London Hydro at (519) 661-5503. The name of the game and the game itself can be used as described or can be easily adapted in whole or part for other subject areas.*

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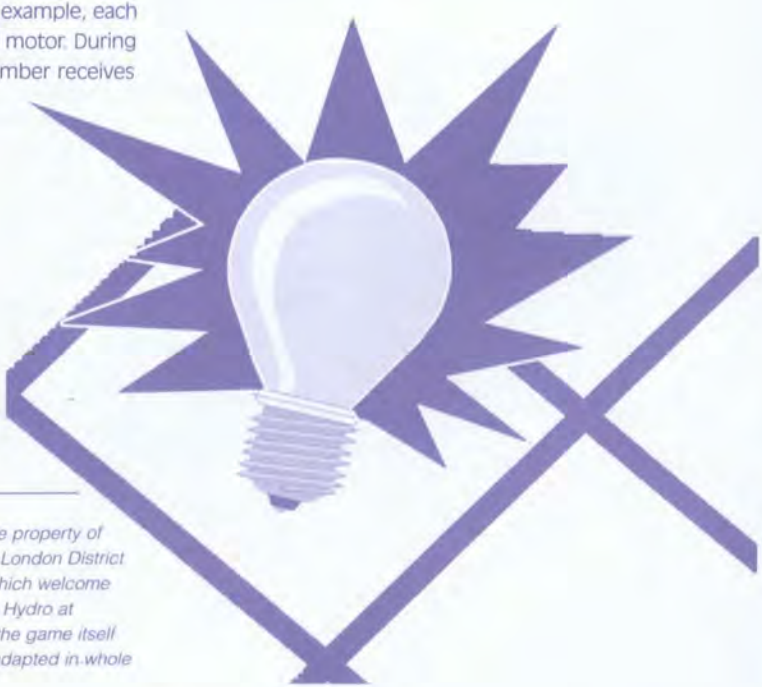

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MESSAGE AND MEDIUM

Knowledge is of little use to students if they do not know how to communicate ideas to others. A further complication in the modern world is that communications technology is constantly changing. Today's students need to learn how to adapt their creative thinking and problem-solving skills to new situations and new media so they can take advantage of opportunities as they arise.

In a world where change is the only constant, **Bill Henderson** teaches students a valuable lesson about the appropriate use of technology. **Dawne Tomlinson** has set up a video, television and film course that teaches students valuable skills that will be useful no matter what field they choose. Creative artists have used many media throughout history, from cave drawings to holographs, to get their message across and explore their inner selves, as **Brenda Rowe-Bartlett**'s students amply show. **Dalia Naujokaitis** explains how her Internet-based projects challenge students to learn how to solve problems, work together and adapt to new situations.

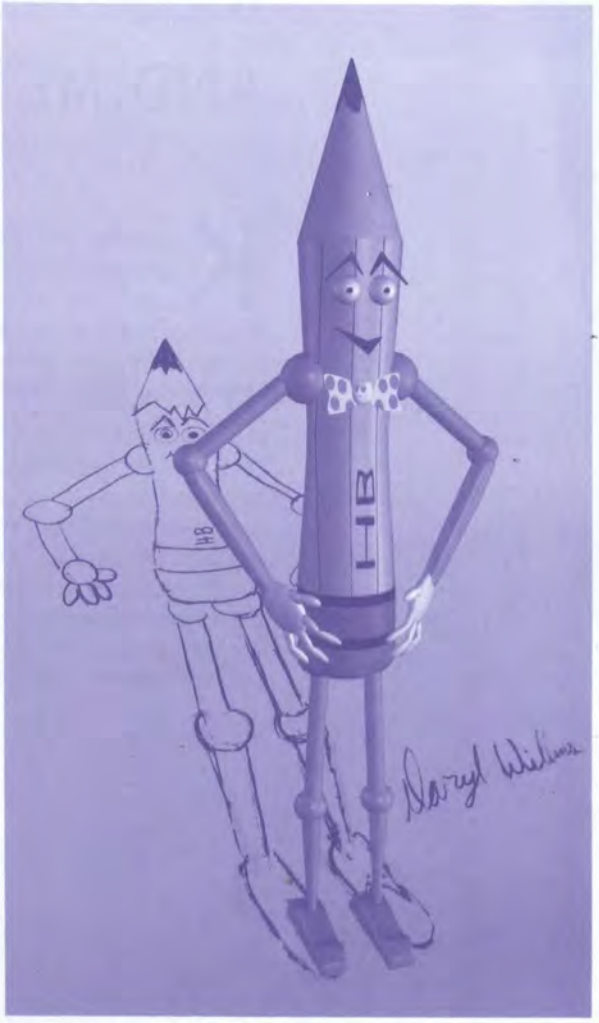
THE HIDDEN TOOLS OF TECHNOLOGY

BILL HENDERSON
ROBERT BATEMAN SECONDARY SCHOOL
ABBOTSFORD, BRITISH COLUMBIA

Bill Henderson, Head of Technology Education at Robert Bateman Secondary School in Abbotsford, has three attributes of a great teacher: vision — he has the ability to foresee and take advantage of advances in technology and teaching strategies; commitment — he is intent on helping his students develop to their fullest potential, and on contributing to the development of technology education province-wide; and a love of learning — he regularly upgrades his skills and recently received his master's of education in curriculum development.

Mr. Henderson's Design Communication and Information Technology programs are popular and highly successful. Classes work on projects for community and industry partners. With this experience and exposure, students have moved directly from Grade 12 into highly skilled jobs. DigiFest, an annual conference initiated by Mr. Henderson, supports this by bringing students, teachers and industry leaders together to keep curriculum relevant and contemporary.

For some time, Bill Henderson tells us, educators have been saying that "the computer is a tool," but for many this is just a catch phrase. If computers are to be used as tools, to create works, then teachers should train the students accordingly. He wants to teach his students to see computers in a way similar to how craftspeople see chisels and planes; how artists see brushes and kilns; how performers see lights and cameras; how the author sees a word processor. Jacob Bronowski



Daryl Willms, Grade 9. Reproduced with permission of the artist.

points out in *The Ascent of Man* that "the mark of man [*sic*] is the refinement of the hand in action."

Mr. Henderson understands how easy it is to get swept up in the "whiz-bang" aspects of new technology but he believes that computers have been around long enough that people should start thinking of them in practical, down-to-earth terms. It is important to remember that the person behind the computer is more important than the computer itself.

Below, Mr. Henderson talks about how he introduces his students to one of the most exciting applications of information technology, computer animation. He first introduces his students to storytelling and animation and then helps them learn to use the computer to realize their own creative ideas.

Transparent Technology

With new technology, every student potentially knows as much as the teacher. In fact, the students can easily surpass the teacher's technical ability as they are afforded the opportunity to use the technology extensively while doing assignments. There is really no good reason to hold students back, so the role of the teacher becomes that of guiding and directing the student. I use the analogy of a ship's captain. I see my students as being on board as the group takes a journey of exploration and learning. Collectively they negotiate the waters, developing expertise and experience, which they share among each other. Students move forward, helping each other along the way. My challenge is to keep the ship and its precious cargo going in the most appropriate direction. It is a direction that, in my classroom and in many across this country, is charted in consultation with curriculum, industry and business specialists.

If you want to get students to use technology transparently, you have to get them focussed on the project not the tools. During the first few weeks of my Design Communications classes, students discuss the artistic side of character development and what it means to tell a story.

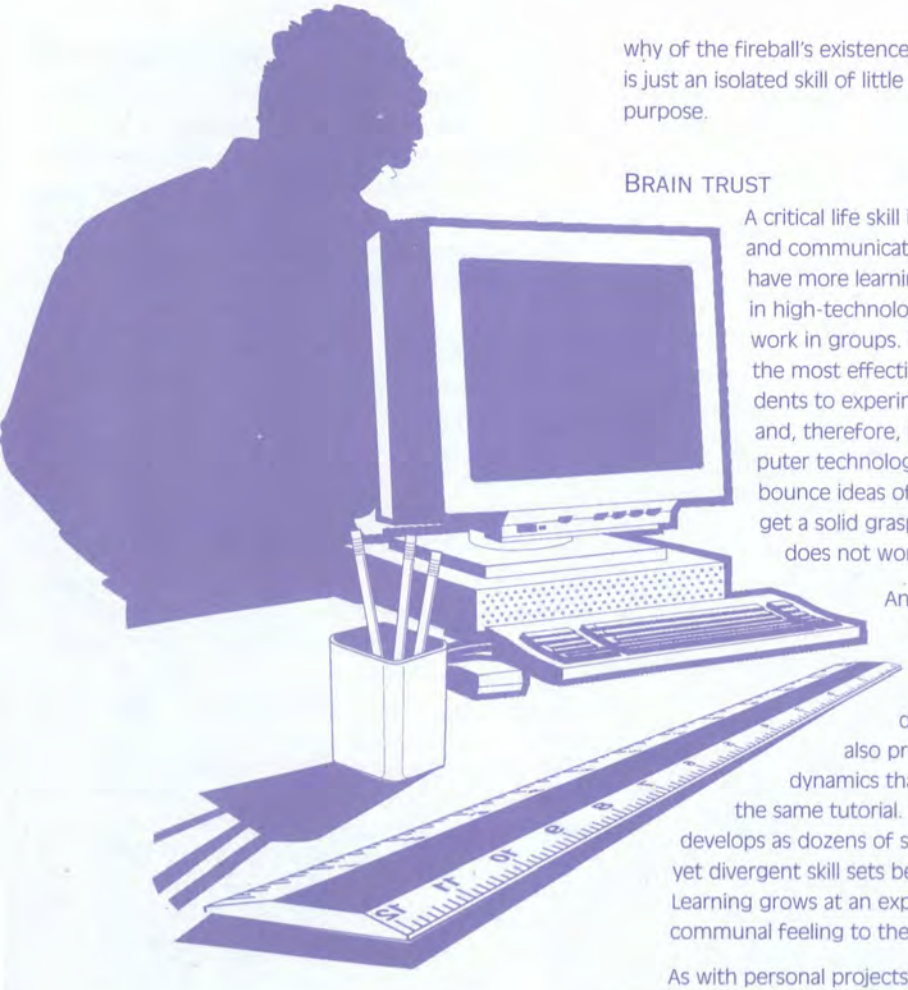
When it is time to work with the tools I find, paradoxically, that it is better to start with very low-level technology rather than the computers. To begin creating a character I ask the students to draw it in pencil. Why pencil? Because it is a familiar piece of technology; so familiar that people take it for granted. It is "transparent" technology. They focus on the character and its story, not on the technology. Unexplored technology, such as the computer and its software, is initially a barrier to creativity.

The Exploration of Technology

After conceptualizing their ideas in two-dimensional sketches, students use the software to create a three-dimensional model of their character and develop their ability to animate it. Their first efforts are usually simple interpretations of their original ideas. This is the skill-development stage of using technology.

I offer a variety of skill-building activities to develop specific technical abilities. Students quickly learn that technology does some things well and others not so well. A few years ago, for example, a girl wanted to create a teddy bear character and make it soft and furry, which is difficult and certainly not a task for a beginning computer modeller or animator. I took the student back to the beginning of the project and talked to her about what she wanted, which was a cuddly character. I was able to suggest how she might get that feeling in other ways: rather than trying to create fur she might make a bear with ears that are bent over so they seem softer. Or, she might have the bear move in certain ways so it would appear softer to the viewer. This allowed her to keep the original intent but use the computer technology in a way that was more appropriate for her skill level.

Students work with tutorials and other "monkey-see-monkey-do," canned learning opportunities to perfect their technical techniques. Their personal projects, such as developing characters, should be just that, personal; projects of which the student takes ownership. Tutorials rarely offer this level of possession. It is all very well, for example, to be able to create a fireball but the fireball has to have a purpose. Unless the students can explain the where and



why of the fireball's existence, being able to create it is just an isolated skill of little creative or marketable purpose.

Brain Trust

A critical life skill is the ability to work and communicate with others. Students have more learning opportunities, even in high-technology settings, when they work in groups. This approach is one of the most effective ways to get students to experiment, try new ideas and, therefore, learn how to use computer technology effectively. They bounce ideas off of one another and get a solid grasp of what does and does not work.

An added advantage of this approach is that it allows students to work on projects they develop themselves; it also produces better group dynamics than having everyone do the same tutorial. The brain trust that develops as dozens of students develop similar, yet divergent skill sets becomes awesome. Learning grows at an exponential rate. There is a communal feeling to the class.

As with personal projects, the best way for students to learn about the use and application of technology is for them to start with a vision and try to realize it with the technology available. While it is likely necessary for the teacher to initiate the first group project, inevitably, students find the group experience valuable and they come to see that I place a special importance on it. The day always comes when some of them ask me when they will be working in a group again. In response, I ask them when they are going to put a group together and create their own project. They are masters of their own success, and the sooner they take control, the better they will fare after graduation.

The personal projects and group work put students in a mode of self-discovery. One of my challenges, then, is to create situations that will give students the feedback they need to learn how to use technology correctly and appropriately. One very effective way to do that is to bring students into contact with professionals in the real world.

A COMMUNITY OF LEARNING

DigiFest is a provincial student/teacher symposium in British Columbia in the area of computer animation education. The two-day event gives educators and students opportunities to participate in workshops taught by industry leaders, and provides a forum for sharing successful strategies in implementing digital communication and arts programs in their schools. Students and teachers from all jurisdictions are invited to attend. For the past two years we have had more than 250 people and 65 schools each year. One of the biggest payoffs of doing this is that the students see first hand the industry's expectations and standards. Hearing the message from successful people in the industry that students are preparing to enter drives the point home. They listen and learn. It backs up the daily message they get in class.

One additional, and very valuable, lesson that goes along with learning how to use technology appropriately is learning how to identify and develop marketable skills. It is too easy to sit down in front of today's technology and get blown away by what it can do. What employers want to know, however, is what graduates can do, think and create. It is not an employable skill to only know how to push a button to get an effect. Knowing when and how to use that effect to enhance or tell a story is a skill employers value.

THE FINAL DESTINATION

Upon graduation, I want students to have some tangible assets for their portfolio. These may be video tapes that demonstrate the students' abilities, talents and accomplishments, or projects they completed for themselves and members of the community. This adds a real-world dimension to their accumulated experiences.

Other venues for taking the students beyond the classroom are the Skills Canada competitions. Three years ago I developed a computer animation event to provide students from across Canada the opportunity to demonstrate their accumulated knowledge in a practical situation. This competition offers much the same experience as final scholarship exams. Industry experts judge student creations, validating the students' preparedness for their future.

The added bonus of these kinds of events is that they also serve to establish common standards for new programs that do not yet have established curricula.

The computer animation industry is enormous and full of promise. Yet students must also realize that it can take you in, chew you up and spit you out a few years down the road. We don't tend to think of high tech jobs as "sweat shop" jobs — yet! I help my students see that using technology isn't the only point. The really important thing is to be able to take any technology, including the "whiz bang" of tomorrow, and apply it creatively to make things happen. That becomes the creative human endeavour; these are the hidden tools of technology.

TURNING THE CLASSROOM INTO A TV STUDIO

DAWNE TOMLINSON
BROOKSWOOD
SECONDARY SCHOOL
LANGLEY, BRITISH COLUMBIA

Dawne Tomlinson of Brookswood Secondary School in Langley created and runs an extremely successful film/television production program that is the envy of schools across Canada. Through arrangements with Rogers Community TV, she gives secondary school students opportunities usually available only to those in prestigious film schools. She started the program five years ago and found space in an unused welding workshop at the school to set up the "BackStreet" Studio. The students who go through the program are in high demand in the television and film industry for jobs after graduation.

Ms. Tomlinson is the driving force behind a number of other innovative projects. She started a peer counselling program, training interested students to give personal support to others, as well as Klown Kids, a travelling troupe of junior students who perform at elementary schools.

Dawne Tomlinson once worked in teaching and television at the same time and loved both, so when the principal at her school proposed creating a program to teach video and film techniques, she jumped at the chance.

Ms. Tomlinson spends considerable time convincing others to try similar programs and even teaches a course about it for other teachers. The program she has created inspires young people, gives them an opportunity to express themselves and teaches creative thinking, teamwork and problem-solving skills they can use on the job in any field, along with technical and production skills well suited to the television industry.

Despite her previous television career, Ms. Tomlinson found herself scrambling to gain the skills and knowledge needed to create the new program, and her success in doing so should inspire others to follow in her footsteps. Below, she shares some of her experiences and gives advice for others considering a similar course.

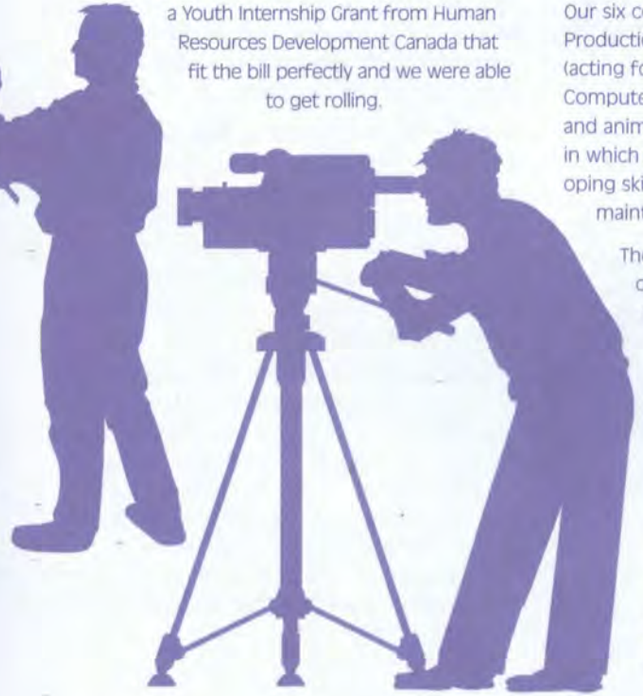
HOW I GOT STARTED

I am a great promoter of video and television programs for high schools. Along with other teachers in the field, I spend a lot of time networking and promoting these programs. The message I want to get out to teachers is that you can do it too.

The whole program started rather humbly a few years ago when my principal took me down to a large empty shop space that we had at the school and asked me if I wanted to turn it into a television studio. The real question wasn't whether I wanted to — I knew for certain that I did — but whether I could. The biggest challenge for any new program is money and especially so in the case of a big project like this.

We wrote up a proposal to the school board to put a program in the school and it was accepted. Based on that, I was able to establish a partnership with Rogers Community TV. Even this left us with nowhere near enough money.

The next step was a long and tedious job of looking for grants and sponsorships. Luckily, I found a Youth Internship Grant from Human Resources Development Canada that fit the bill perfectly and we were able to get rolling.



That was only the start of the long haul networking, building the program and acquiring new skills that is typical of this sort of venture. The bigger you go, the more of each is required. One thing I quickly learned was that my experience was not nearly enough for what I wanted to do. I went back to school at night and got my broadcasting diploma from the British Columbia Institute of Technology.

And the learning never stops. It is absolutely essential to stay in close contact with the industry to run a program like this. In addition, you have to learn how to use each piece of equipment as you acquire it.

WHERE CAN IT ALL LEAD?

At Brookswood we have a well-rounded program that includes six courses in video, television and film production beginning in Grade 9. Many of our students graduate straight from Grade 12 into the industry. Others go on to post-secondary work in specialized fields ranging from script writing and production to acting and managing.

Our six courses are Video Production 9/10, Television Production 11 and 12, Film 12, Media Performance (acting for the camera and broadcast journalism), Computers and Television (editing, special effects and animation) and Television Technical Assistance, in which students learn to run a studio by developing skills such as scheduling and equipment maintenance.

The Brookswood program is not the only option for students interested in this field. Other schools in British Columbia have chosen to focus their programs on broadcasting to the school or the local community. Another high school has become a real powerhouse in screen writing. In addition, there are dozens of smaller initiatives in which teachers extend the options for drama, art and marketing programs.

We chose to go the route we did for a number of reasons. First, the television and film industry is the third largest employer in British Columbia. This generates interest among young people in the

province who are attracted to the field because of its challenges and rewards. On the other side of the coin, the industry is in constant need of new skilled employees and has some incentive to support programs that will educate them.

The various courses introduce the students to the skills and then allow them to build on them. Video 9/10, for example, starts with the basics of creating a video that presents ideas in a visually appealing way. Students learn a huge lesson here about appropriate use of the medium: talking heads are not only boring to watch on video, but they are also a waste of the technology; a travelling speaker could accomplish the same thing as a video for less money and could do it better because he or she could respond to specific audience questions. Students also have to learn just how much "content" you can put in a video and what kinds of information are conveyed best by this approach. A major focus is on storytelling.

The television courses extend the skills students learn in Video 10. In Grade 11, students learn how to prepare for and shoot a video and then to edit it. The next year they refine these skills and also write their own screen plays, analyse other productions and put together a "director's cut," a creative compilation of all the good visual stuff they have done while here that they can use to apply for a job or for admission to a post-secondary program.

Although we have a very professional program, we do not meet industry standards for everything. Working with film, for example, is very expensive, so we shoot on video using film techniques. On the other hand, we do have very high-quality editing equipment because one of the major focuses of our program is a national television show called *BackStreet*, for which our students do the pre-production work, as well as shoot and post (which means to edit in the industry vernacular). To produce the television show, we had to invest in the right sort of equipment.

Selling the Idea at Your School

You cannot, and I have not tried, to include all the information you need to start teaching video or television production in an article this length. At most, I can give you an idea of what is possible and some sense of direction. I can tell you that you can successfully set up this type of program with a lot of hard work, some luck and a bit of knowledge.

One immediate hurdle for anyone creating a new program is convincing colleagues and school and board officials to support it. To do this you have to overcome one immediate perception problem: the fact that many people's impression of video is tainted by the garbage they see on television.

The truth, however, is that putting together a video is an immensely complicated process that requires a wide range of skills. The most important thing to understand, then, is that you can start small.

Programs launched on a shoestring exist all across the country. Some began with a single handicam and a teacher's or student's desire to record a drama production or graduation ceremony, and grew from there. I have a colleague here in British Columbia who bought a single camera and built his program up, one piece of equipment at a time, to the point that he now runs a very impressive program. You can establish contacts with teachers like him and with industry to help you get going.

Starting small, you can gradually improve your abilities and build a solid track record of producing quality work with students that will help sell enhancements to the program. When others see that video is an exciting and viable medium, that you can teach children and that children respond enthusiastically while learning a wide variety of useful job skills, you will gain more supporters.

I have mentioned many times — perhaps too often — that video is a lot of work. On the one hand that may scare people off. On the other hand, students are excited by this technology and get an even bigger boost from accepting and meeting what are very daunting challenges. Tackling hard work and facing risks intelligently brings big returns, and that is one of the lessons we want to teach our students. What better way to teach them that than by demonstrating it to them?

AESTHETIC GROWTH AND DEVELOPMENT

BRENDA ROWE-BARTLETT
BISHOPS COLLEGE
ST. JOHN'S, NEWFOUNDLAND

Brenda Rowe-Bartlett of Bishops College in St. John's was the driving force behind the school's new traditional-style galley for student artworks (The Treasury). This gallery attracts visitors from all over the city and surrounding areas, who are amazed by the calibre of artistic merit produced by adolescents in levels I, II and III (Grade 10, 11 and 12 students) of the high school art program. The presence of the gallery on site at Bishops College reinforces the artistic aspirations and aesthetic abilities of art students within the entire Avalon East School Board, in addition to those at Bishops itself. Visiting art professors from Canadian universities and graduates from art programs across Canada are equally impressed with the aesthetic and artistic output from these young artists. Many former students have enrolled in fine arts programs at university and have gone on to sell their works.

Brenda Rowe-Bartlett is an energetic advocate for the arts, seeing them as a viable method of integrating many other subject areas of the curriculum without surrendering the fundamental status of fine art and its ability to stand alone on its merit. She believes that progressive education for the future must involve the whole child, who is taught to face the future as an integrated whole, rather than as a fragmented and segmented patchwork of individual pieces. Ms. Rowe-Bartlett directs her students' learning through an "inward-outward" approach to creative development. In a guided learning experience, she encourages her students to define and develop their personal interests in other subject areas (science and creative writing, for example) through the program's mandate: visual communication and aesthetic perception.

She provides students with regular feedback and trains them to aesthetically and emotionally critique their own work. Individual and group analysis is an ongoing process in addition to preparing for student art exhibitions. Student artists are exposed to the issues of entrepreneurship as classes confront and solve marketing and ethical problems that resemble the "real world" for those who hope to become professional artists.

BISHOPS COLLEGE FINE ARTS DEPARTMENT

The fine arts program at Bishops College places a strong focus on the aesthetic growth and development of the art students from a very individual perspective. Even though my students enrolled in the

Sleeping Muse. Pen and ink. Dylan Cag, Grade 12. Reproduced with permission of the artist.

Looking Within. Oils. Meg Ripley, former Grade 12 student. Reproduced with permission of Bishops College.

different art studio courses often have their own personal stylistic preferences and technical strengths or weaknesses, they are all invited to participate in a journey of self-exploration designed to heighten self-esteem and creative risk taking.

In September, I ask the students to actively participate in the curriculum by posing several questions for them to think and write about in their personal journals. These journals are never collected or marked but I periodically take time for discussion and to have students compose essays about the nature of artistic expression and/or the essence of a specific artist's intention. I do evaluate the students' contributions to these discussions and their essays.

Initially, I focus on what the students want to communicate about themselves and topics that concern and interest them as individuals. I do not stress artistic or technical ability at this point, because I feel it is more important to establish a positive learning environment in which the students are comfortable and accepted. Facing a blank canvas or block of clay can be very threatening to the unestablished, insecure student who has just left junior high behind. However, it is vital that the students know within the first week the criteria for excellence and preplanned growth that are built into the program.

The students must know exactly what is expected of them and be given the time to think about the personal commitment this will require of them. I carefully outline individual portfolio requirements and academic procedures and explain the "extended day" policy that is recommended to those planning to go on to study at a post-secondary art institution following graduation.

SIX GUIDING QUESTIONS: WHO, WHAT, WHY, HOW, WHEN AND WHERE

The thrust of the students' work is rooted in the following questions, which require careful analysis as the year progresses.

- Who are you? Who are you as you interact with others at home, school and work? To what degree are you being true to your inner self? Do you want to discover your identity?
- What do you value? What concerns you most right now about the world in which you are living, provincially, nationally and internationally?
- Why do you value these things? Why do these issues concern you? Why are you not concerned about something else?
- How do you value these things? That is to say, what evidence do you generate to prove that these are valued by you? How do you demonstrate your concerns for world peace or saving the whales, etc.?
- When do you feel your current value system will change? When did you first realize you cared about unemployment or taking care of the environment?
- Where do you think you will be in 5 or 10 years with regards to these concerns? When do you think you will have solved the problems? To what degree can you personally solve these problems? To what degree is it necessary for you to work with others on finding a solution to global problems? Are you alone in thinking the way you do about a particular issue? Is your journey a personal one on which you must travel alone? Will you be joined by others on a global trek of discovery and resolution?

Of course, it is not always possible to reach any final conclusions to these questions, and my students and I realize that. I use the questions as a teaching tool to help the pupils focus on a particular idea or image that is meaningful to them. Students are often surprised and delighted to finally get the

opportunity to intellectually and visually explore a topic of interest and/or concern to them in an art class. Oftentimes they are not asked to communicate their personal views on the actual topics being taught in their various other courses. Instead of listing and discussing the causes of World War II, they may want to discuss and visually depict an image based on the civilian casualties of warfare. Possibly, this may be a part of their family history or it may simply be an interest. The art program provides a visual opportunity for the students to infuse their curriculum with relevancy and authenticity.

The program acknowledges fantasy art and many other modern styles as well. Many student artworks are quite humorous and non-threatening.

No student is ever encouraged to research and/or discuss or depict a topic that he or she is not comfortable with at the time. Relevance is the issue here. No artwork can be created within an intellectual vacuum when one is teaching realism and its associated technical skills. It is much easier to visually document or create an image when the essence of the theme or purpose is clearly established intellectually by the artist. Similarly, students are more willing to spend the time required to obtain the necessary technical skills when the subject matter is meaningful to them. They are facilitated by the art educator to take ownership for their artwork! Thus, even though the general art curriculum and required graduation requirements are established by the provincial Department of Education, these students have the opportunity to give their art portfolio a personal slant.

Despite the tremendous amount of research and personal effort that usually goes into rendering the artworks, the final evaluation is largely based on the degree to which the students have satisfied the aesthetic and technical requirements outlined in the Elements and Principles of Design section of the provincial art education guidelines. The evaluation is further based on how well the students have mastered the following curriculum outcomes, which are also outlined in the guidelines: the artistic process, visual communication, cultural role, personal growth and perception/response. While other subject areas are often used as integrative tools for "educating the whole child," my colleagues and I stand firm in our conviction that art education must be provided and evaluated on the basis of its educational benefits.

Art Portfolio Examples

Who Are You?

At the beginning of the year the students might be asked to produce a graphite sketch based on their own reflection in a mirror. As time passes, students might like to select from a list of options an assignment that deals with the depiction of only one aspect of their own personality (e.g. a sense of humour, open mindedness, etc.). Another time, I encourage the students to create an artwork that depicts their greatest strength (their achievements in sports or survival in the great outdoors, for example). Students have come from a realistic, physical portrait to a personality profile that may be rendered in the abstract.

What Do You Value?

The students create a still life image based on five meaningful objects that reflect something about them. Art evaluation is partially based on the composition, textural variety and technical skill development in media usage. Students may be later required to repeat a similar still life in a particular style of a famous artist. Oftentimes students learn more about Picasso or Cézanne when they create a work in their respective styles than simply memorizing the characteristics intellectually. After I establish a stronger educational rapport with the individual classes, I ensure the list of objects I provide, from which students choose the items they will draw, include objects from the personal environments of the students in the class. If the class contains many pupils who are involved in athletics and science, the list will contain references to sports equipment or scientific paraphernalia.

The "Issues" Assignment

I ask my students to compose a list of topics related to their personal or group social concerns. We discuss these in class as if they were about to commence a written research paper for a social studies or English class. However, instead of producing a written report, they are respond visually. Written materials and even interviews may also be conducted and included along with the visuals if the students wish.

Occasionally, guest speakers are brought in to further enlighten the class on a particular topic when

necessary. Many videos are also available from the social studies and humanities departments to help promote an in-depth understanding of the social issues. The topics are generated during class discussion but each individual carefully selects the topic he or she wishes to fully develop into a visual project.

What may be a sensitive issue to one student could be irrelevant to another. As a veteran teacher of 24 years, it is incumbent upon me to ensure the students' final topic is one they are personally comfortable with for the duration of the project. Since this assignment is not commenced until late in the year, everyone has settled in and become comfortable with the guidelines for the assignment. The results are often amazing in terms of the students' aesthetic understanding and technical development in comparison with the beginning of the year. More importantly, however, the students really value the process and have communicated a positive reaction to retaining it as part of their portfolio, regardless of the mark distribution for the class! Students have asked me to retain this assignment for future classes.

Exhibition Requirement and Evaluation

Throughout the year, I teach students to market their work, as several art exhibitions take place within the Bishops College Art Gallery (The Treasury). Usually there is one all encompassing show at the end of the year for which a student art selection committee is formed. While no artwork is ever hung without the student's permission, I try to ensure that everyone has at least one piece on display (check out the Web site at **http://www.bishops.ntc.nf.ca**).

Oftentimes the artworks are sold with both the student artists and the Fine Arts Department financially benefiting. The school portion of the art sales goes directly back into the program to purchase more equipment or to finance further art exhibitions. Through their direct involvement in planning and executing the art exhibitions, the students soon become familiar with confronting and solving the following tasks: selecting only the highest quality artworks for exhibition, pricing, matting and framing, advertising the show through the local media, designing a brochure to advertise and document the show, establishing a guest list and gallery hours, updating the patrons' committee, music and reception committees, and transferring the images to the Bishops College Gallery On-line.

In 1992, I established the Bishops College Permanent Student Art Collection in order to ensure that future art students would be able to catch a glimpse of their ancestral artistic heritage. I saw too many high quality artworks leaving the building in the hands of the wonderful artists who had created them. Now every year at the graduating ceremonies one to four artworks are presented to the permanent collection and hung at different locations around the school.

The selection is juried so the students feel quite privileged to have their images selected. (Students are often very harsh critics of their own work and this recognition helps them overcome self-doubt.) On December 1, 1997, when the Bishops College Art Gallery was publicly opened, I also presented the City of St. John's with a piece by one of my students. It has become the foundation of the Permanent City Collection of Student Artwork to which three pieces will be added each November 25. Other city schools have been invited to participate in the juried selection that I will coordinate. In addition, any other high school student in the city may submit a request to have public viewing space in City Hall at various times throughout the year.

I hope to expand this concept across Canada. It is about time that adult Canadians realized the powerful aesthetic contribution being made by Canadian youth on a regular basis. It is my educational goal to establish permanent student art collections right across Canada in all the capital cities, which I would call Salute to Canadian Youth Artistry. We need to enter the students' world and acknowledge their visual imagery as we learn to appreciate their positive energy.

Imprisoned Identity. Mixed media (styrofoam, Barbie™ doll, acrylic paint, found objects). Charlotte Matchim, Grade 10. Reproduced with permission of the artist.

TOOLS FOR THE TIMES

DALIA NAUJOKAITIS

ST. ELIZABETH
ELEMENTARY SCHOOL
OTTAWA, ONTARIO

For 17 years of her 29-year teaching career, Dalia Naujokaitis, an elementary teacher at St. Elizabeth School in Ottawa, has challenged students and teachers to meet the rapidly changing demands of an information-oriented society. She has been using computers as an educational tool with all her students, both gifted learners and those with special needs, since 1981.

Her classroom is a dynamic place where cooperative learning and on-line collaboration with other schools around the world are everyday activities. With her students, Ms. Naujokaitis has created and managed nine GrassRoots programs through SchoolNet. Her program for gifted learners for grades 4, 5 and 6, draws students from 22 schools around the city. The students spend one day a week in her class.

Using the skills and information they gain there, they frequently return to train students and teachers at their home school in the uses of the Internet, Web page design, and environmental or social action programs.

Dalia Naujokaitis has taught everything from Kindergarten right through to Grade 8, but now she has, in her words, the "best job of all," teaching a resource program for gifted children in grades 4 to 6. Dalia sees the program as giving her students an opportunity to be on the cutting edge of new educational technology, where they can explore new ways of learning and become leaders and teachers themselves.

Her approach to teaching is best illustrated by her practice of developing on-line projects with her class. From concept to completion, the students are in charge every step of the way.

LEARNING ON-LINE

Critical thinking, flexible and adaptable problem solving, knowing how to use technology, the ability to be both a leader and a team player, and communication skills are the tools of our times. One way I teach these skills in my gifted program class is by developing an on-line project.

In an information-based society, students not only need to know how to search out new knowledge, but must also know how to evaluate what they have discovered. In a nutshell, students need to become critical thinkers, analysing and processing information and then communicating what they have learned. The last is very important — until they can communicate what they have learned to someone else and make it real for that person, whatever strategies or skills they may have acquired are irrelevant.

An on-line project is one in which the students use the Internet as a communication and information tool. Students may gather data using E-mail or the World Wide Web. They evaluate their findings and then finally share their results in hard copy or by publication on the World Wide Web. An on-line project should not be an add-on to the curriculum; instead it should use technology to enhance the delivery of the curriculum.

Tool Set 1: Critical Thinking and Problem Solving

Taming the Tube (**http://www3.sympatico.ca/dalia/tametube/intro.htm**) is a good example of the type of on-line project my class develops.

I was looking for a way to integrate the potential of the Internet into the curriculum for a unit on media awareness. I wanted something to get the children interested that would bring many objectives, skills and outcomes into play.

My first step was to have the students do a survey of their own television use. They made charts to collect data: how many hours of television watched, what shows, which shows were more popular with boys and which with girls. They came up with some interesting in-depth questions: How many TVs do you have in your house? Do you watch TV and eat at the same time? Do you think there is too much violence on TV? They collected this data and made charts to show what they had learned. Up to this point, the children were thinking on the scale of their own neighbourhoods, homes and classroom.

Then I caught their interest by suggesting they could take it further, beyond what was familiar to them, out into the bigger world. I reminded them that with our computer and modem, we could contact other children from across Canada and around the world and ask them to join our survey. We could find out how our TV viewing compares to that of children in Newfoundland and British Columbia. They were amazed and excited by the idea.

To gather participants from other regions, I set about advertising the project on several educational listservs such as INCLASS, a listserv on SchoolNet (**http://www.schoolnet.ca**) geared especially for teachers using the Internet in the classroom. I gave the project a fun, easy-to-remember name: Taming the Tube. I have found in doing a number of these projects that clearly stating the deadline, procedures, and including two or three sentences outlining the pertinent curriculum objectives are essential to getting people to participate.

For Taming the Tube, the curriculum objectives were multidisciplinary. The students used the scientific method to formulate hypotheses, gather data, test their predictions against the real-world data obtained, and then sought explanations for any divergences. In math, they learned basic statistical analysis and graphing of results. They practised communication skills both in the writing process and presentation by publishing their results and reports. Finding the location of participants on a world map through latitude and longitude became a study in geography and cultures.

Once the call for participants was out, the kids worked out the rest of the details of actually creating and implementing the project themselves. Although I knew what needed to be done, I didn't do any of this work because I wanted the students to learn by doing for themselves. I stayed in the background, keeping them on track and ensuring that they didn't forget anything. By the way, the Grassroots Program on SchoolNet (**http://www.schoolnet.ca/grassroots**) features a good process that teachers can follow for designing an on-line project.

I used a brainstorming session to walk the students through the planning process, suggesting questions such as: Where will you get the information? How will you collect the information? How will you display your results, as a write-up or as a graph? How long do you have to complete the project? How and where will you present your findings?

Without communicating the results to someone, the whole undertaking, though valuable in its own right, would remain a single class activity. The Internet offers not only the opportunity to collect data from all over Canada and around the world, but also the capability to publish the results for a potential audience of millions. So, as a final step in the project, we designed, created and uploaded a Web site to the Internet, telling everyone about the project and our findings. You can obtain space for a Web page from SchoolNet or a local Internet service provider. Some word-processing programs will automatically convert text to HTML (HyperText Mark-up Language), the computer language that displays your text and pictures on a Web page. Stand-alone programs to convert text to HTML are also available.

Just in case you were wondering, I don't have a room full of expensive, powerful machines, despite the fact that I do this kind of on-line project quite often and use technology regularly in the class. For a long time, I only had one computer, an external modem and a single phone line. Because of this, and because I want to encourage lots of discussion and cooperative work, my students do all of their designing and layout of Web pages on paper first before putting them into the computer.

Taming the Tube exceeded our expectations. Instead of the dozen participants I thought we might get, we had hundreds! It was an enormous project. But when it was finally finished and the Web page launched on the Internet for the world to see, the students were thrilled. They had done a new and unique project all by themselves.

Tool Set 2: Teamwork, Leadership and Communication

I found that implementing an on-line project requires that both teachers and students acquire skills very quickly. Together with the students, I created a training plan that coped with constant change, especially when technology was concerned. I trained a core group of students who then became mentors for the rest of the class. If I didn't know a concept, I assigned a student or a team to investigate and report back to the group. When we formed cooperative groups, which I will describe in a minute, I assigned one of these student mentors to each group. The training in necessary skills became part of the project.

These skills fall into two areas: technical computer skills and cooperative learning skills. With the assistance of point-and-click help buttons and manuals, students and teachers gain computer skills with practice and a good sense of humour. The humour is necessary when your server goes down an hour before a deadline, or a tiny mistake means the HTML won't display properly, or the Internet service provider sends its bill to you personally instead of the school!

Both students and teachers need training in the application of cooperative strategies to group learning. For on-line projects, I divide the class into groups of four or five. During the brainstorming planning session, each group takes on a specific responsibility. I do not assign these jobs, rather the students work out among themselves how the work is going to be divided up. Again, I just make sure that they do not forget anything and that the work is divided evenly. Within each group, the group responsibility is divided into individual jobs.

Then, to make sure that everyone gets a chance to try every job, and everyone has a turn being both a team player and a leader, we rotate the jobs around the class. So, if Group A's responsibility is correspondence, Joe checks the E-mail this week and Joan checks it next week. Once everyone in the group has

had a turn, the whole group switches jobs with Group B, which is responsible for graphing the results. Group B takes over creating text for the Web page, and so on.

Organizing the teams in this way helps everyone learn, keeps it interesting, and makes sure that everyone contributes to the project. Each person is trained in both teamwork and leadership. These are skills that will be increasingly in demand as the new technologies grow in both the school and work environment.

Putting the Tools to Work

Project-based learning blends traditional subject-driven goals with the objectives of authentic learning. We found that projects dealing with real issues, whether the TV watching habits of 10- to 12-year-olds or the environmental impact of overconsumption, provided excellent opportunities for students to locate information, design experiments, test hypotheses, solve problems on-line and communicate with students across Canada and around the world. The students become highly motivated, take ownership of their learning, and delight in publishing their findings to a real audience on the Web.

The most exciting thing for the students and myself has been the realization that the World Wide Web goes far beyond simply being a passive information delivery tool. It is a dynamic, alive and interactive medium promoting a different style of teaching and learning. Through the Web, students become creators, not only consumers, of knowledge. On-line projects encourage participation, resource building, development of essential learning strategies and, above all, communication and sharing of ideas.

THE 1997 CERTIFICATE OF ACHIEVEMENT RECIPIENTS

The 1997 Certificate of Achievement recipients are listed here by province, along with a short description of them and some of their award-winning teaching ideas. If you are interested in contacting one of these outstanding teachers, please call 1-800-268-6608 or send an E-mail (**pmawards@ic.gc.ca**).

Newfoundland

Jane Scaplen, a French immersion teacher at **Sacred Heart Elementary School** in Marystown, regularly uses the Internet to make distances disappear. By integrating computer technology into her teaching she provides her students with continuous access to French-language use, and broadens their geographic and cultural awareness. They improve their academic and social skills, and gain valuable familiarity with new technologies. She and her students initiate and participate in many on-line educational activities. Two of their Internet-based projects were recognized as exemplary by the International Society for Technology in Education's Special Interest Council on Telecommunications. In addition to her classroom involvement with technology, she acts as a resource for other teachers. She is recognized provincially and internationally for her contributions and accomplishments in this field.

Patrick Wells' students can repeat a favourite field trip to the beach over and over again because the whole thing is captured on their computer. The Intertidal Zone Web site allows students from **Bishops College** in St. John's to visit the beach and collect samples for analysis without ever leaving their keyboards. This is only one of many ways that Mr. Wells uses technology to promote learning. Based on his philosophy that technology should be an integral part of curriculum, he regularly has students make multimedia presentations or create research papers electronically. His enthusiasm has spread and today students are eager to get into his classes. Virtually every group at Bishops, from individual science classes to basketball teams, has its own Web page.

Nova Scotia

Janice Farrell and **Stephanie Krszwda**, two remarkable teachers at the **Colby-St. Joseph Complex** in Sydney, amazed local business people and parents by turning their Grade 1 and 2 charges into budding entrepreneurs. In 1996–97 about 55 six- and seven-year-olds learned how to run a business, and then actually did it. The Grade 1 class produced a cookbook of recipes requiring no cooking. The Grade 2 students created the Slappy Happy Card Company, making all-occasion greeting cards, and another company that made peel-and-stick labels promoting fire safety. Ms. Farrell and Ms. Krszwda provided guidance only as the children negotiated a loan from the school principal, set up shop, and decided how to market their products and what to do with the profits. The young students learned about teamwork, partnerships, informed risk-taking and commitment to a project, and were responsible for their own decisions.

The parent or guardian of each student in **Diane Racette's** classes gets a call from the teacher every month. She also sends a regular newsletter home with students. A French immersion teacher at **Oxford School** in Halifax, Ms. Racette believes in keeping the community up to date on what is going on in the classroom, and in keeping students in touch with the community. For example, in a recent social studies unit students acted as a planning committee determining the future use of their school. They visited city hall, collected data from the archives and canvassed their neighbourhoods for further information on demographic trends. They used the information to create proposals, backed by databases and spreadsheets, that they presented and then discussed with classmates. Ms. Racette was also key to the development of a new program that will help students prepare for the transition from elementary school to junior high.

New Brunswick

Andrew Campbell of the **MacNaughton Science and Technology Centre** in Moncton is a rare bird, though his media studies course is no "bird course." MacNaughton serves three area high schools as a centralized electives school, allowing Mr. Campbell the singular opportunity to first create and then teach his course. Students produce several films, music videos, CDs, CD-ROMs and radio commercials each year. Media studies is a broad, multidisciplinary subject. This integration shows students the relevance of their learning, and improves their knowledge and skills in many areas. Mr. Campbell strives for excellence in himself and his students. His energy, dedication and enjoyment of both his students and his work are essential elements in the success of the program.

Wendy Coyle teaches a methods and resources class for grades 6 through 12 at **Stanley High School** in Stanley, where the local school is the focal point of the surrounding rural community. In only a few years, her influence has been enormous on students, teachers and the community as a whole. Ms. Coyle has introduced a number of programs for assisting and inspiring students, including those with special needs. Her Peer Helpers and Peer Tutors are students, chosen by their peers, who volunteer to organize various student activities and to help others improve their learning abilities, self-esteem and motivation. Her newly formed Junior Achievers are currently learning business development and managerial skills. As these programs evolve, students are increasingly eager to take part.

QUEBEC

One of the educational records that **Robert Arsenault**, **Jean-Marc Gosselin** and **Maurice Normand** are most proud of is an auditor's statement. Their school, the **Centre de formation en entreprise et récupération** in Victoriaville, is a working business and the statement is one way of showing how well it is run. The business carries out a number of money-making ventures such as recycling hardware from abandoned hydro lines. In the process, the students learn how to start and run a business. The teachers have spent their entire career developing hands-on approaches to helping students who have been failed by conventional education. The students at the Centre de formation, for example, are 16- to 19-year-olds who had not previously succeeded in advancing beyond primary levels.

Ginette Larose of **École du Sacré-Cœur** in Masson-Angers likes to get her primary-level students cultivating new growth, often in tangible ways. For example, she created a program in horticulture that saw students up to their elbows in earth, seedlings and fertilizer, teaching them how to identify different types of crops, how to grow them, and the usefulness of plants for maintaining good health and a strong immune system. She also encouraged them to enter a contest run by the town's environmental committee to come up with a slogan for local environmental programs. The students entered the contest, and won. These and many other rewarding hands-on activities have created considerable enthusiasm among Ms. Larose's students, who all signed a letter of support when their teacher was applying for this award.

Is a student council just a student council? Not to **Brian Potter**, who sees it as a learning opportunity for students at **John Rennie High School** in Pointe Claire. Under his direction the council has greatly expanded its responsibilities and achievements and has taken on a new structure to enable it to do so. Instead of being elected to the position, students now have to apply for a position as if it were a job. They are selected for positions by the students who are currently on the board. Mr. Potter helps on both ends by teaching applicants how to prepare for the selection process and showing senior council members how to conduct interviews and review applications. The idea has caught on and is being studied by other schools in the area.

When **Thérèse Sauvé** wanted to show her students at **École St-André-Apôtre** in Montréal the science behind reproduction, she went looking for a guinea pig. She found two, as well as two mice and two birds. The class fed and cared for the animals until the birth of their offspring, after which good homes were found for them. Exposing her students directly to a subject is a favourite approach of Ms. Sauvé's. In the past she has also invited a professional actor to teach her students elocution, has connected them with pen pals from other countries and has made extensive use of the Internet. When asked why she makes all this effort to prepare for classes, she replies that she doesn't see it as work but as an exciting adventure. She creates the same attitude in her students, who find themselves confronted by materials so special and mysterious that they cannot help but ask questions.

Bernard Tousignant of **École Secondaire De-La-Salle** in Trois-Rivières has long succeeded in drawing large numbers of students into science and technical programs. When asked how he does it, he has a one-word answer — democratization. Mr. Tousignant has long lobbied authorities to get them to open advanced programs to more students. He believes that if you

ask more of students and give them more support, they will respond; he has proven this approach works. In the classroom, his students face daunting challenges in subject areas such as optics but see an immediate return on this work when they are able to do real science in astronomy. Mr. Tousignant reinforces his point by getting access to professional-quality instruments for students to do their research.

ONTARIO

John Bradley is the Mathematics Department Head at **St. Matthew High School** in Orléans. The school is known locally as St. Math's, largely because of Mr. Bradley. Using a personal touch to get students involved, he coaches several of the math teams, preparing them for provincial and national competitions. The importance of math is highlighted throughout the school. Student achievements are honoured, math is promoted as a key discipline for overall learning, "math anxiety" in students and parents is addressed, and the enrichment that extracurricular math activities offer is advertised. Mr. Bradley obviously loves math and math teaching. He guides and encourages the other teachers in his department, has created seven board-wide exams and co-authored a marking document that has improved student performance and confidence.

Joan Brent, a 20-year veteran at the **Woodman-Cainsville School** in Brantford, is known for her eagerness to try new teaching practices and her ability to create stimulating learning environments. Her Grade 2 students, mainly from economically disadvantaged, and many times single-parent, families, respond enthusiastically to her own passion for scientific discovery. Using the resource-rich Galaxy Classroom curriculum called Fixer Uppers (from TVOntario, the provincial educational channel), her students learn how to use technology, do experiments themselves, and communicate the results of their studies concisely and clearly. Add to this Ms. Brent's special talent for making natural science exciting and rewarding, and the results are students who develop a more positive attitude towards problem solving.

Glenn Byford wants his students to understand the difference between listening to and merely hearing music. The entire music program at **Lasalle Secondary School** in Sudbury leads students in gradual steps to a deeper understanding of music. For example, in one exercise students listen to a piece once and then are asked to write a story that goes with the music during a second listening. Later they are asked to transcribe what they listened to. The students not only analyse music, but they also apply their lessons in the school's junior, intermediate and senior jazz bands, all of which have distinguished themselves in performance and competition. Mr. Byford invites many professional musicians to do clinics and concerts and, beginning this year, a professional musician or composer is serving as artist-in-residence at the school.

Judith Crompton, from **Sir Winston Churchill Secondary School** in St. Catharines, believes in second chances. Any student can understand math and those who already do can perform better. One of the ways she shows this is by letting students opt for follow-up courses and by giving them a second shot at exams and assignments. Even students who are firmly convinced that mathematics is not for them respond to her teaching, and requests for timetable changes so students can get into her class are a regular event. Ms. Crompton has also promoted improvements to the curriculum and mathematics competitions and has recently implemented a tutoring program at her school.

Sharon Davis teaches elementary grades at **St. Gregory's Separate School** in Etobicoke. She has a child-centered classroom, and enjoys motivating her students to learn, as is evident in her planning, teaching and discipline strategies. She provides firm, consistent expectations of behaviour and encourages students to work to the best of their ability. Her interested and caring attitude encourages the children to look beyond themselves. They help each other learn in the classroom, with paired reading exercises and joint presentations. The students also write monthly letters to an elderly woman, visit an extended care facility at Christmas, and participate in organizing several school liturgies. Regardless of ability, Ms. Davis ensures that each child has a special role in these projects.

James Ferris is the linchpin of the music program at **Parry Sound High School** in Parry Sound. His teaching philosophy is strongly rooted in his Christian faith and his dedication to the local community is something he shows through his actions rather than simply his words. He creates a positive environment in which his students can develop the self-esteem they need to challenge themselves, and participates with school bands in many community activities. Mr. Ferris is also on the cutting edge, using innovative teaching methods as well as new technology in the classroom. Students use computers, for example, to support everything they do from composing music to managing band finances.

Even a small school can set up important partnerships with multinational companies. **André Fillion** of **École Rose des Vents** in Cornwall, a small French school with 226 students, has proven this. For example, a partnership with Lego Dacta™, the educational wing of the Danish toy company, resulted in a project called "Au boulot... avec la techno" (Let's get to work with technology). Using special Lego™ blocks and a computer, Mr. Fillion's students make models that can move manually or have their motion simulated on a computer. The students made a number of objects that taught them important lessons in physics, such as a roulette wheel, which demonstrates some basic concepts of motion and velocity.

Susan Fisher of North Bay's **Chippewa Secondary School** did not wait to be asked when the need to develop the school's information technology program became apparent. After attending the Ministry of Education's Updating Workshops in 1986, she initiated a new Grade 11 information processing course for advanced and general-level students. This course is the foundation of Chippewa's Grade 12 Information Technology Management Program, which she started in 1996. It is evident that, with a combination of creativity and leadership, Ms. Fisher continuously initiates teaching practices that spark the enthusiasm of her students and lead them to high achievements, whether it is their increased grasp of information technology or their improved entrepreneurial and managerial skills.

Dena Hansen, **Blair Hilts** and **Diane Lessels** of **Georgian Bay Secondary School** in Meaford are a model of teamwork for their students. The three led the development of an English, history, communications and business studies publication entitled *Canada Learns: Canada Remembers*, a history of World War II designed, written and published by students for students taking general-level Grade 10 courses. Many of the members of the publication team had weak reading, writing and speaking skills. This project gave them a context in which to develop their critical and creative thinking, and gave them confidence in their abilities and improved their academic and social skills. The team of Ms. Hansen, Mr. Hilts and Ms. Lessels provided excellent organization, careful monitoring and attention to detail, encouraging and inspiring the students to achieve the highest standards.

When a teacher in the English Department at **St. Joseph's High School** in Windsor is stumped by a literary question, invariably a student will run down to room 131 to get the answer. **Anthony Johnston,** in room 131, seems always to have it. Classically educated in Ireland, Mr. Johnston's lifelong love of literature and for learning is immediately evident whether he is answering an obscure question or making the characters and plot of a classic novel come alive for his students. He is an inspiration to students of all ability levels; he spent several years teaching at an alternative high school and had remarkable success getting students there to finish school. Graduates now working in a variety of fields consider Mr. Johnston a friend and, more importantly, as the person that set them on their successful life path.

Bob Malyk has taught biology at **Ridley College** in St. Catharines for 15 years. During that time, biology has become the most popular program in the Science Department. In a school with only 480 high school students, there are nine classes of biology in grades 11 through OAC, largely because of his enthusiasm, innovations and class projects, such as field trips to New Brunswick, Costa Rica and Galápagos. Mr. Malyk developed software so students could do remedial work on their own time, and as university-bound achievers emerged, established Ridley's

Advanced Placement Program in biology (an international program with directors at Princeton). Most recently, his senior students have become involved with an American facility in original research aimed at isolating the human gene for deafness.

Penny McLeod has spent 25 years watching good and bad ideas for teaching chemistry come and go and has unfailingly found the better ones. She has spent her entire career sorting out the methods that work, and her students at **Thornhill Secondary School** in Thornhill have benefited immensely. They get to take advantage of a wide variety of options, from working with industry and science professionals to taking part in special programs for girls. Ms. McLeod has shown that she can help students from a wide range of backgrounds: she is able to help gifted students excel and is also commended by her colleagues for her determination to see weaker students succeed. All the while, she continues to experiment with new ideas, having recently brought integrated curriculum and new technology to her teaching.

David Mowat, a biology teacher at **Haliburton Highlands Secondary School** in Haliburton, has taken his students out of the classroom and into the woods, literally. Five years ago, he started ELM (Energy, Lifestyles, Matter), a program based in environmental science and the humanities designed to place students in an outdoor environment that becomes a theatre for nurturing their commitment to the human community. Strong communities, Mr. Mowat believes, encourage young people to explore and develop their individual talents. In ELM, students from Grade 9 through OAC work in teams to teach elementary students about nature and the role of human society in protecting it and making it flourish. The program is interdisciplinary, with literature, drama, biology and computer students, beginners and seniors, typically working together.

Stavros Naxakis, a chemistry and physics teacher at **Vaughan Secondary School** in Thornhill, is an inspiration to all who know him. His rapport with his students, a gentle yet tenacious teaching style, and leadership abilities make him a highly respected member of the school. Dr. Naxakis is always able to relate even obscure concepts to real life or present a visual demonstration, making otherwise stressful courses with heavy workloads enjoyable. Under his guidance, Vaughan students consistently score in the top five percent in an international chemistry contest, the University of Waterloo's Chem 13 News Contest. He combines a famous sense of humour, an impressive educational background and a genuine love of teaching to make a valuable contribution to his school and society.

Thanks to their geography teacher **Mark Oliver**, students at **Napanee District Secondary School** in Napanee have the world at their fingertips, so to speak. Beginning in 1992, Mr. Oliver introduced Ontario high school students to Geographic Information Systems (GIS) technology, which allows them to study the "real" world to a much greater extent than traditional tools do. Computer outreach means that students can acquire, analyse and contribute information that is actually useful, and feedback from community and other groups continually reinforces the value of this educational experience. Mr. Oliver has created a GIS lab that is the envy of educators across Canada and the United States. He is a strong advocate of partnerships between secondary and post-secondary institutions and the corporate world.

Stephen Oliver teaches computer science at **Central Huron Secondary School** in Clinton. In his Digital Media Studies course, students in grades 10 through 12 learn to work effectively in small teams, drawing on the individual talents of members as they master interactive technology and the dynamics of the creative process. But the emphasis is not so much on tools as on understanding the context in which such tools can best be used. Much time is spent discussing technology as it relates to social change. To date, Mr. Oliver's students have collaborated on multimedia productions with a wide range of educational or business content. From Mr. Oliver's course, Central Huron graduates gain the communication skills they need to be more competitive in pursuing employment or advanced education.

As computer site manager and teacher, **Michael Pannabecker** masterminded the introduction of information technologies at **Phelps Central Public School** in the northern community of Redbridge. With an awe-inspiring ability to circumvent roadblocks, he developed his resource teacher's room into a

state-of-the-art Internet lab, motivated and instructed his fellow educators, and demonstrated to parents and students what the ability to use the latest information technology can mean to their lives. To date, he has trained more than 100 local students in Web design and development techniques. One of these students has already won an American Internet design award. Mr. Pannabecker is currently Program Coordinator for the Nipissing Board of Education in North Bay.

A good teacher can use any subject matter to teach students critical thinking, analysis and teamwork. **Robert Perkins** of **Madawaska Valley District High School** in Barry's Bay responded to the growing demand for changes in curriculum by showing students, parents and his colleagues just how much can be done with an art program. He created an art curriculum that is highly structured, but also promotes creative thinking. Mr. Perkins encourages students to tackle complex tasks, but he ensures that these tasks never become too daunting by showing students how they can break them up into discrete parts and work with others to complete them. In the end, the students learn that art is made up of a whole range of skills that can be applied to other subjects.

MANITOBA

Although **Ste. Anne Elementary School** in Ste. Anne is a small rural school with only 225 students, it is well equipped with a computer and science lab and even a computer-operated weather station on the roof. **Daniel Forbes**, the school's computer administrator, worked hard to establish a new computer and science lab at the school when it split from the local high school by soliciting grants and donations to bring in high-quality technology. In addition to creating these facilities, Mr. Forbes teaches students how to use them and has organized a leadership team of Grade 8 students to help teachers from other grades and to teach small groups of younger students.

As Head of the Mathematics and Computer Science Department of **Sisler High School** in Winnipeg, **William Korytowski**'s dedication to student development is apparent inside and outside the classroom. He integrates concepts from business, engineering and computer science into his lessons to make them interesting and relevant. His ability to draw on each student's existing skills and strengths when teaching challenges his advanced students while still encouraging others to learn. Mr. Korytowski coaches students for the national mathematics contest, gives after-hour tutorial sessions, initiated a partnership with the University of Manitoba enabling Grade 12 students to take university-level calculus for credit, created and funded the Sisler High School Math Award, and wrote, co-authored or reviewed numerous textbooks and curricula.

Corinne Kutcy of **Silver Heights Collegiate** in Winnipeg leaves nothing to chance. Every moment of her basic French, French immersion or advanced placement French classes is planned with care and executed with enthusiasm. She presents new concepts in a consistent, organized way, using a variety of innovative instructional methods. Her love of French and learning is transmitted to every student; students look forward to French class. Ms. Kutcy's energy and dedication extend beyond the classroom. She coaches the girl's basketball team, prepares students for a provincial French speaking contest, and directs the school's annual musical, in addition to organizing activities for her gifted education class. Twelve of her former students are now French teachers themselves.

Lynwood Madder of **Earl Grey School** in Winnipeg has high standards, and his students rise to meet them. Responsible for a pilot all-girl science, math and technology program, he had a direct role in its success. His classroom management eliminates discipline problems, and his enthusiasm for the curriculum captivates the students. This yields impressive results: attendance in his classes exceeds 96 percent, and students' grades are higher than average, both for the school and on the Canadian Test of Basic Skills. Mr. Madder gives pre- and post-lesson tests to highlight the students' learning, brings science to life with hands-on experiments in almost every class, and leads many field and overnight trips.

Kristin Peterson of **Sisler High School** in Winnipeg has influenced educational practices in her school and province. She was instrumental in creating several

innovative programs at Sisler. Single-sex classes for compulsory courses have resulted in substantial grade increases for students. A modified math course using individualized learning programs, specialized texts, and frequent skills testing reduces early failure in this important subject. Her latest project is an English program to improve students' communication and literacy skills. Ms. Peterson also works to improve education in Manitoba, promoting the teaching of literature, the Mathematics Fair and Gifted Student Institute. She has co-authored English curriculum support documents and home-schooling reform legislation.

It is largely due to **Lesley Peterson** that university-level calculus and English courses are taught at **Sisler High School** in Winnipeg. As Head of the English Department, she has pioneered curriculum development, teaching methods, school-community relations, and the promotion of student achievement. Sisler's Self-Directed Learning Program embodies her vision of how learning can be different: more personal, relevant, challenging and successful. She introduced innovative reading and writing techniques, started a full-credit creative writing program (now in its 11th year), stimulated the school's arts program, and developed, with science educators, a Grade 12 course called The Language of Science and Technology. Most of all, Ms. Peterson is able to instil in students the love of learning and ideas.

SASKATCHEWAN

A French immersion, science and physical education teacher at **École Henry Kelsey** in Saskatoon, **Marcia Klein's** motto is "Reach for the stars." Her love of nature and learning is obvious to students and fellow educators alike. To develop her own expertise, she regularly attends workshops, conferences and training sessions. She uses a wide range of innovative instructional techniques to help students discover their natural world. For example, to create a butterfly garden, Grade 2 students researched and chose plants attractive to butterflies, designed and planted the garden, then gave detailed tours to schoolmates, parents and other visitors, explaining their work. Ms. Klein has written or co-authored several field guides as well as course material for science programs in the field and classroom.

ALBERTA

Dawne Marie Aune thinks girls in vocational programs get a raw deal from the education system. Determined to do something about this, she turned the cosmetology program at **Bowness Senior High School** in Calgary into a retail business and showed her students how they could get personal and professional fulfilment in this field. Before undertaking this latest challenge, Ms. Aune pursued a teaching career that began in social studies and quickly branched out into curriculum reform. She took a leading role in implementing new curriculum and played a major part in helping her colleagues adapt to change. This enthusiasm and drive continues today — Ms. Aune now teaches 400 students in grades 10, 11 and 12 with the help of only one aide.

Monica Etherington, a Kindergarten teacher at **Swan Hills School** in Swan Hills, thinks children should know now some things that their parents only learned much later in life. To Ms. Etherington, a positive approach to a rapidly changing future requires that children be aware of the impact of human society on the environment. It also means that from an early age they should be comfortable with technology, and her students use the computer regularly. She provides opportunities for them to learn by play, organized activities and cooperation with others, while encouraging flexibility and the willingness to make the best out of every situation. Most of all, she hopes to instil in her students the confidence to say "I'll try" rather than "I can't."

Laurie Jewell teaches Grade 10, 11 and 12 Career and Technology Studies at **Harry Ainlay High School** in Edmonton. This is a somewhat misleading description of her work, however, because she does more than teach. She equips her students with the necessary business and technological skills to succeed in the modern workplace. Interviews, consistent constructive feedback, and an emphasis on organization and time management skills keep students focussed and motivated. Ms. Jewell's main talent is linking the curriculum with life outside the classroom. She uses community resources, creates partnerships with businesses and invites guest speakers into the classroom. She also sponsors the school's Skills

Canada Club and Junior Achievement Business Challenge Club. Club members have won medals at provincial and national business competitions.

Sandra Ogrodnick has led her students at **Leduc Composite High School** in Leduc on field trips to locations ranging from the physics laboratory at the University of Alberta to "Galaxyland." The latter is a local theme park where students analyse the physics behind five rides. They use triangulation to measure the height of each ride and then determine the kinetic performance of the moving parts. In all these activities, Ms. Ogrodnick's goal is to make students curious about the world and to show them that they can achieve. She firmly believes that students will not learn to love mathematics or the sciences unless someone shows them they can succeed at it. She has done just that and her students have responded with superior performance on provincial exams.

British Columbia

Mitchell Barnes is a teacher at **Strawberry Vale Elementary School** in Victoria who makes it possible for young children to work with scientists to create educational software. The latest of a number of such rewarding projects is *Tree Tales*, a CD-ROM about forest ecology and forestry science. It was produced by 19 Grade 6 and 7 students with the help of research scientists from federal and provincial forestry ministries. In the process, Mr. Barnes' students had fun learning not only about photosynthesis, decomposition and the carbon cycle, but also about computer technology. *Tree Tales* is now being used in schools throughout the province. Other offerings in the CD-ROM series focus on freshwater fish and traffic safety.

Mathematics and sciences were never strong points for **Agnes L. Mathers Elementary Junior Secondary School** in Sandspit, but that changed with the arrival of **Peter Gajda**. He quickly put in place a program that combines learning at the students' pace with higher performance standards, and students responded enthusiastically. His students today can do mathematics at their own pace but they know they have to master 80 percent of the subject matter. Mr. Gajda transformed the school's computer lab, making more and better computers available to students. He did this without an increase in budget, often upgrading computers and wiring networks himself. In response, his students are doing better in mathematics and reaching levels in science fairs that are unprecedented for the school.

Why would a 78-year-old grandfather take the time to put together a Prime Minister's Awards nomination package for his grandson's teacher? Because he is a former educator himself who appreciates the incredible efforts **Peter Guzzo** of **James Whiteside Elementary School** in Richmond makes for students. The school runs a French immersion program and Mr. Guzzo specializes in encouraging students to develop the self-respect and creativity necessary to succeed in this special environment. His approach is based on involvement — everyone from students to parents has a place — and hard work. Those who take up the challenge find themselves completing integrated curriculum involving everything from reading exercises and music to mathematics and computer training.

Edith Illes has spent her entire career looking for trouble and then doing what she can to make it go away. Right out of teacher training, for example, she spent two years teaching on a reserve where the school had no running water. Since joining the staff at **Signal Hill Elementary School** in Pemberton, she has taught a young boy recovering from a gunshot wound to the head, and then a class of students with behavioural problems. She reached them through food, integrating food preparation into the curriculum and cooking with the class each Friday afternoon. Her services will continue to be valuable as the school struggles to meet the needs of a rapidly growing community. Signal Hill's classes are all bursting with students from a wide variety of backgrounds.

Kyle Kirkwood of the **South Hill Education Centre** in Vancouver is not only an educator, but also an advocate and mentor. He quickly develops a rapport and mutual respect with his adult students, many of whom are taking English as a second language. His classroom is friendly and interesting, and his lessons include many hands-on activities. Mr. Kirkwood encourages his students to learn from everything around them, pointing out free

sources of information, such as libraries, parks and government agencies. Despite their previous school experience or the language barrier, the students do well. Several have achieved perfect scores on provincial exams; others have earned scholarships and entered university programs all over the world.

Among his peers at **West Vancouver Secondary School** in West Vancouver, **John Klassen** is considered to have been a major force in bringing about much-needed change to the school's mathematics program. This includes a 20 percent increase in participation in Math 12 between 1991 and 1997, and a steadily decreasing rate of failing grades. Among other things, Mr. Klassen designed and introduced a highly successful remedial learning program for incoming Math 10 and Math 11 students who have previously had difficulty in math courses. With typical determination, he also has been a leader in the use of graphical calculators in mathematics departments, an effort finally rewarded by British Columbia's decision to integrate this technology into new senior-level curriculum beginning in September 1998.

David Vandergugten teaches computer studies in the remote northern community of Fort St. John, where he himself went to school. His students at **Bert Bowes Junior Secondary School** benefit from his philosophy of educating the whole person, for Mr. Vandergugten has taught art and French as well as math and computer science. In the latter, he makes a phenomenal contribution, guiding the integration of technology into all the school's curricula, designing computer courses, establishing local networks and providing students and faculty alike with access to the latest technological tools. In 1997, he prepared the school for its very successful involvement in the APEC (Asia Pacific Economic Cooperation) Conference in Vancouver. APEC representatives visited the school to make a presentation.

Sandy Wohl of **Hugh Boyd Secondary School** in Richmond believes that science education requires a broad range of thinking skills, cooperative learning, time management and a career perspective. In the course of his 25-year career, he has developed activities combining science, language arts, art, history and career education. A typical project might require a student to write a mystery using symptoms of a disease as the clues. This type of assignment reaches students of all language and ability levels and makes plagiarism difficult. Mr. Wohl's commitment to science education has led him to share his creative techniques with other educators. He runs workshops, contributes to many committees and has written dozens of papers, teaching manuals and textbooks.

Joseph Wood's students distinguish themselves with impressive performance in mathematics. Whether it is provincial exams, on which they regularly outperform other schools, or the Pascal, Cayley and Fermat mathematics competitions, in which they place in the top levels, the students of **Killarney Secondary School** in Vancouver are a force to reckon with. They get that way by completing a wide variety of learning activities. Some of Mr. Wood's techniques are tried and true and others use new technology, such as graphical calculators. These approaches have helped students at all levels to succeed. He makes his classroom equally welcoming to boys and girls; the latter comprise half of his classes.

Northwest Territories

As a northern teacher for nine years, **Elizabeth Tumblin** is aware of the challenges facing her Grade 6 students at **Joamie School** in Iqaluit. Mostly Inuit with low levels of literacy in English and Inuktitut, they are caught in social and economic upheaval that undermines their own culture. In classrooms where student apathy, disruptive behaviour and erratic attendance were the norm, Ms. Tumblin has had extraordinary success in increasing learning achievement. She uses telecommunications technology and unique teaching methods, such as highly interactive small group study, geared to local cultural circumstances, to create an exemplary learning environment. Students contribute to a database of research on subjects such as racism and the history of the Thule and Dorset peoples.

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