Laptops as a Vehicle for Making Constructionism Real

"...Only inertia and prejudice, not economics or lack of good educational ideas stand in the way of providing every child in the world with the kinds of experience of which we have tried to give you some glimpses. If every child were to be given access to a computer, computers would be cheap enough for every child to be given access to a computer." - Seymour Papert and Cynthia Solomon (1971)

It took eighteen years since Papert and Solomon published this prediction, but in 1989, Methodist Ladies' College (MLC) in Melbourne, Australia embarked on a still unparalleled learning adventure. At that time the school made a commitment to personal computing, LogoWriter, and constructionism. The unifying principle would be that every child in the school (from grades 5-12) would own a personal notebook computer on which they could work at school, at home, and across the curriculum with a belief that their ideas and work were being stored and manipulated on their own personal computer. Ownership of the notebook computer would reinforce ownership of the knowledge constructed with it. The personal computer is a vehicle for building something tangible outside of your head - one of the tenets of constructionism. By 1994, 2,000 teachers and students had a personal notebook computer. This school, like most serious workplaces has a computer ration of more than one computer per worker (teacher & student).

Today, nearly 20,000 Australian school children[1], in both private and public schools, carry a personal notebook computer between home and school. MicroWorlds, LogoWriter's successor, is on most of those hard drives and used across disciplines. This paper sites learning stories from MLC that are intended to serve as metaphors for similar experiences in classrooms across Australia. Schools like MLC made a decision that was clearly on the right side of history.

Personal computing in schools not only challenges the status quo of computers in schools, but creates new and profound opportunities for the teaching staff at MLC. Schools often take computers so seriously (ie... hiring special computer teachers, scheduling times at which students may use a computer) that they trivialize their potential as personal objects to think with. Computers are ubiquitous and personal throughout society, just not in schools. After six years, ten trips to Australia and work with more than a dozen Australian "laptop schools" my tales of personal computing in practice are still met with disbelief by American educators who seem to be more concerned with wiring than learning.

The challenge of getting 150 teachers to embrace not only the technology, but the classroom change that would

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[1] Dixon, 1996

accompany widespread and continuous Logo use was enormous. Thus far the school's efforts have paid off in a more positive approach to the art of learning on the part of students and teachers.

A Critical Choice

The laptop initiative inspired by MLC Principal, David Loader, was never viewed as a traditional educational research experiment (although research has been conducted by external researchers). Success was expected. Personal computing was part of the school's commitment to creating a nurturing learning culture. Steps were taken to ensure that teachers were supported in their own learning by catering to a wide range of learning styles, experiences, and interests. It was agreed that personal computing was a powerful idea more important than the computers themselves. What was done with the computers was of paramount importance. LogoWriter was MLC's primary software of choice. Today, many laptop schools, including MLC, use MicroWorlds. Logo is a natural software choice for schools committed to personal computing because of Logo provides a powerful intellectual laboratory vehicle for self expression. Logo mediates a conversation between the learner and herself while providing an environment in which personal ideas are nurtured into product - in a child's own voice.

Although educational change is considered to occur at a geologically slow pace, the MLC community (parents, teachers, students, administrators) immersed itself in some areas of profound growth in just a few short years. The introduction of large numbers of personal computers has served as one catalyst for this "intellectual growth spurt." MLC teachers routinely engage each other in thoughtful discussions of learning, teaching, and the nature of school. While similar conversations undoubtedly occurred prior to the introduction of personal computing, today's discussions are enriched by personal learning experience and reflections on the learning of their students in this computer-rich environment. Traditional curricula, pedagogy, and assessment are constantly being challenged. One teacher recently suggested that mathematics no longer be taught. Such an idea would have been unthinkable in a conservative church school ten years ago.

Teachers in many schools rightfully view the computer with suspicion as just one more mandated fad or as a threat to their professionalism as large Orwellian teaching systems are unloaded on the market place. Why should a teacher challenge convention and learn to use the new technology when the USA ratio of student to computer is between eight and seventy to one[2] . How many after-school workshops does a teacher need to attend before they can get an ImageWriter ribbon. The dirty little secret of the educational computing movement is that many students never get to use a computer for a substantive purpose. Schools routinely spend a fortune

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[2] Depending on who you believe. The Los Angeles Times recently reported that California schools have one computer capable of running Netscape (or MicroWorlds) per 70 students.

building fortresses, called computer labs complete with special furniture, decontextualized learning and trivial computer-use.

The personal computing experience at MLC has been different. In less than five years, 2,000 children and teachers own personal computers and approximately 40 teachers in that one school have made Logo part of their repertoire. Some schools spend more time deciding on a spelling workbook. Given the changes that have accompanied classroom computer use, this initiative would have been cheap at twice the price.

Challenging Our Notions of School

The act of asking every parent to purchase a notebook computer for their child[3] was not nearly as courageous or challenging as the way in which MLC has chosen to use computers. The quaint idea of drilling discrete facts into kids' heads with computer-assisted instruction was dismissed and so was the metaphor of the "computer as tool." The popular tool metaphor is a based on the business paradigm of increasing productivity and efficiency. I would argue that there is seldom an occasion in school when the goal needs to be increasing a student's efficiency or productivity. The discussion of educational tools is an odd phenomena. One would be hard pressed to find another example of the tool metaphor used historically in education literature. Schools that can not agree on anything have decided that word processing/database/spreadsheet - whatever that actually means in practice - should be the major focus of a student's computer-based learning experience. There are few if any calls to hold the tool proponents accountable for their claims, in any way proportionate to the critics who ask for proof of what Logo delivers.

Cynics might suggest that the tool metaphor is the result of commercial forces. Tools carry with them preconceived notions of what will be produced - paper-based assignments that can be completed in a thirty mintue trip to the computer lab. A subtle shift away from paper-based projects has emerged in many laptop schools. While many educators seem obsessed with paper and now web-based products, much of what is created by children in laptop schools is dynamic and lives on the screen.

Constructionism

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[3] Each MLC teacher interested in owning a personal notebook computer received a substantial subsidy from the school in order to purchase a computer. The school decided against fully funding the computer for two reasons. 1) The teacher had flexibility to purchase the computer that met his/her specific needs and 2) Teachers were being asked to make a personal commitment to personal computing. Each year a $400-$700 stipend has been available to teachers interested in upgrading their hardware or purchasing peripherals. Other schools have employed similar schemes, asked teachers to pay the entire cost of the laptop via payroll deductions or purchased computers for every teacher.

MLC has chosen to guide its thinking about personal computing by the ideas of "constructionism" and by viewing the computer as "material." Constructionism is the idea of Jean Piaget and extended by Seymour Papert to mean that learning is active and occurs when an individual finds herself in a meaningful context for making connections between fragments of knowledge, the present situation, and past experiences. The person constructs her own knowledge by assembling personally significant mental models. Therefore you learn in a vibrant social context in which individuals have the opportunity to share ideas, collaborate, make things, and have meaningful experiences. After the first year of using laptops, the seventh and eighth grade humanities teachers asked for history, English, geography, and religious education to be taught in an interdisciplinary three-period block. This scheduling modification allowed for students to engage in substantive projects. Ubiquitous computing creating a context in which the ideas of "block scheduling" and Ted Sizer became important to teachers and students alike.

The computer as material metaphor is based on the belief that children and teachers are naturally talented at making things. The computer should be seen as an intellectual laboratory and vehicle for self-expression - an integral part of the learning process. In this context a gifted computer-using teacher is not one who can recite a reference manual, but one who can heat-up a body of content when it comes in contact with the interests and experiences of the child. This teacher recognizes when it might be appropriate to involve the computer in the learning process and allows the student to mold this personal computer space into a personal expression of the subject matter.

> *I believe that every American child ought to be living in the 21st century... This is why I like laptops - you can take them home. I m not very impressed with computers that schools have chained to desks. I m very impressed when kids have their own computers because they are liberated from a failed bureaucracy ...*
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> *You can't do any single thing and solve the problem. You have to change the incentives; you ve got to restructure the interface between human beings. If you start redesigning a learning system rather than an educational bureaucracy, if you have incentives for kids to learn, and if you have 24-hour-a-day, 7-day a week free standing opportunities for learning, you're going to make a bigger breakthrough than the current bureaucracy. The current bureaucracy is a dying institution.* - Us Speaker of the House of Representatives, Newt Gingrich (Wired Magazine, August 1995)

When Seymour Papert and Newt Gingrich are on the same side of such an important issue. What is the other side? While the future model of computing may shift from portable notebook computers to networked terminals everywhere, Australian schools will already have years (perhaps decades) worth of experience with the problems and promise of universal access to computation. School leaders challenged by getting teachers to acknowledge the presence of even one computer in their classroom will have an insurmountable crisis on her hands when every kid comes to school with a computer in their shoe. Perhaps the kids won't come to school at all. If the focus of a school is on the delivery of facts, then students already have access to more information outside of school. A refusal to acknowledge the impact of information technology on learning will diminish the long-term viability of schooling.

Staff Development

While every MLC teacher is expected to use technology in appropriate ways, their learning styles are respected and catered for via a range of professional learning opportunities. This idea is at the core of MLC's approach to staff development. In-classroom consultants such as myself, visiting experts, conference participation, peer collaboration, university courses, courses offered by the school's community education department, and residential whole-learning experiences all accompany the common afterschool workshop. Teachers have identified that sharing ideas with colleagues and the residential events have been their most rewarding staff development experiences.

MLC also recognizes outstanding Logo-using teachers by reducing their number of classes and asking them to assist other teachers in their classrooms. It is not uncommon for one teacher interested in sharing a recent insight to voluntarily offer a workshop for colleagues. Other schools have initiated action research groups as a vehicle for extending the learning of teachers.

Teachers at MLC were introduced to computers by being challenged to reflect on their own learning while solving problems of personal significance in the software environment, LogoWriter - the software the students would be using. These teachers come to respect the learning processes of their students by experiencing the same sort of challenges and joy. The teacher and learner in such a culture are often one-and-the-same. Other teachers find the enthusiasm and pride of their colleagues infectious. Schools like MLC used LogoWriter (and now MicroWorlds) to help free the learner to express herself in unlimited ways - not bound by the limits of the curriculum or artificial (school) boundaries between subject areas. One of the most exciting results of giving students personal computing is that learning can take place anywhere - at your desk, under your desk, on a nature hike - and anytime - during class and outside of school hours. In fact, many of the most extraordinary

Logo projects created by students integrated ideas learned during class and built upon them in personal projects.

Logo

LogoWriter (and its more modern successor, MicroWorlds) are the result of more than twenty five years worth of research by Seymour Papert and his colleagues at MIT. Papert has been committed to extending the ideas of Piaget by designing open-ended software construction environments in which learners may express themselves in undetermined ways while making connections between personal interests, experiences, and knowledge. Tens of thousands of teachers around the world use Logo in their classrooms.

Students in laptop schools use Logo across the curriculum in numerous and varied ways. A student designing a hieroglyphic word processor, a longitudinal rain data grapher, or Olympic games simulation must come in contact with many mathematical concepts including randomness, decimals, percent, sequencing, Cartesian coordinate geometry, functions, visual representations of data, linear measurement, and orientation, while focusing on a history topic. An aspect of ancient Egyptian civilization was brought to life by first drawing Egyptian urns and then designing pots that portrayed contemporary Australian life. Their teacher remarked at how traditional pencil and paper artistic skills no longer created an inequity in personal expression. A sixth grade girl was free to explore the concept of orbiting planets by designing a visual race between the planets on the screen. The more the student projects blur the distinctions between subject areas, the more the static notions of curriculum are rethought. Fantastic examples of student work abound.

Two particular projects by MLC students serve as examples of the ways in which they challenge us to rethink the organization of schools. Seventh grade students were assigned the task of designing a LogoWriter program to solve a linear equation, such as $3X + 4 = 16$. While such a task is typically too advanced for twelve year old students, the girls at MLC have gained much mathematical experience through their computer use and are therefore capable of solving such problems. One girl went well beyond the assignment of solving the equation by not only writing a computer program to solve similar equations - she created an elaborate cartoon of a girl walking into her bedroom, complaining to her mother about her difficult maths homework, and then a magical computer appeared and showed the user how to use the equation solving program. The student extended the typical dry algebra assignment with great joy by demonstrating her creative art and communications abilities. Another student's linear equation solving program included the playing of a complete Mozart sonata. Every note of the sonata had to be programmed in a way the computer understands. The mathematical experiences of both students were greatly enhanced because their computing environment allowed them to express their

mathematical knowledge in their own voice. There is great hope for schools when student's interests and experiences are encouraged to converge with the teacher's curriculum.

In traditional settings a student might be embarrassed to show his or her work to the entire class. The experience of laptop classes suggests that not only are kids eager to share their work, but they often praise the work of others by asking, "how did you do that," and then integrating the new technique into their own projects. Project work does not automatically end when the assignment is due. Kids routinely continue work on a project because it satisfies their requirements above and beyond the requirements of the curriculum. Teachers have observed that the students are quite collaborative in Logo/laptop classes and that their social interactions tend to be more work-related than those of their peers.

Another learning story illustrates how teachers have been compelled to reflect on their role in the learning process and take progressive action based on observations of student learning in a computer-rich environment. The French teacher at MLC was provided with a French language version of LogoWriter. It was originally thought that their students might find it interesting to "speak" to the computer in another language. One French teacher was intrigued by the idea, but did not know anything about LogoWriter. She felt comfortable asking a maths teacher for help. (This type of professional collaboration is now commonplace at at schools like MLC.) The maths department offered some eighth grade girls the opportunity to do their maths assignments, not only on the computer, but in French. Students in several classes were intrigued by the challenge. A maths teacher asked his colleague how to say a few phrases in French so that he could leave comments in French on their students' projects. This teacher's demonstrable respect for his student's work and colleague's subject area is exceptional by contemporary standards.

A few weeks passed before the French teacher visited the maths class. The teacher was not only pleased to observe the students learning mathematics, computer programming, and French, but was ecstatic to find that the girls spontaneously speaking French. This veteran teacher later reported that she had never witnessed students of this age actually speaking French outside of a French class lesson. In the LogoWriter environment language is active - the computer does something if you combine words in the right or wrong way and you receive immediate feedback.

This experience has caused a small group of teachers from a variety of disciplines to propose that the school allow them to create a French immersion class in the junior secondary school. Teachers who have not used much French since university are so excited by the learning of their students that they are willing to practice the

language along-side the students they are teaching. Now, one seventh grade class does all of their LogoWriter assignments in French LogoWriter. This sort of professional risk-taking is more common in constructionist environments than in traditional school settings. Risk-taking is an essential element of self-esteem and a critical characteristic of great teachers.

Another language teacher at MLC recently remarked that there seemed to be much more talk of French LogoWriter use by other subject teachers than in the language department. There may be an important idea in her observation. Perhaps the language department does not see the use of Logo in their discipline as revolutionary. However, mathematics, science, and humanities teachers are now excited about French!

MicroWorlds has enlarged the canvas on which students can express their ideas. The addition of parallelism, paint tools, digitized sound, buttons, sliders, multicolored shapes and text boxes have not only made a broader spectrum of curriculum-related projects possible, but produce student output that is more aesthetically pleasing to teachers who may lack an understanding of the process skills used in the construction of a Logo project. Projects created by John Paul College teacher, Josie Hopkins' high school science students are extraordinary in the creative ways kids model complex genetics, physics and chemistry phenomena using MicroWorlds.

Challenges for the Future

Laptop schools face the obvious challenges associated with helping teachers become better Logo programmers and keeping the computers functioning. However, the focus must remain on classroom innovation rather than on technical issues. A wide variety of professional development activities need to be available on an ongoing basis in order to engage new teachers and maintain the enthusiasm of veterans). Laptop schools to encourage the collection of "Logo literature" - a canon of exemplary Logo projects that may be deconstructed by other students and become part of the school's culture. We are also working to provide students with opportunities to create more interactive programs. Most of the Logo projects designed by students in laptop schools have been expository in nature - databases, reports, timelines, stories, tutorials. Ironically, much more needs to be done to use Logo in more computational contexts such as math and science. Much has been accomplished using very little Logo. This is both a tribute to the dedication of their teachers and to Logo itself.

Laptop teachers (like too many of their colleagues around the world) have faced enormous class sizes for years. When I first began working with MLC in 1990 teachers were content with classes of thirty students (an unfortunate luxury for some American schools). Many of the teachers had years of experience as *instructional* leaders. The traditional classroom models of pedagogy and student activity allowed for inflated class size. Most

children were working on the same task and most problems had one solution - always known to the teacher.

A classroom built upon constructionist principles makes many more demands on the teacher, the physical space, the schedule, and the social/emotional/intellectual engagement of the learner. In 1993, many MLC teachers began to question their ability to be effective in a large class. The introduction of laptops and LogoWriter created a vehicle for open-ended projects personally conceived by one student or a small group of students. Often neither the teacher or the student know how the project will progress. This requires a teacher to spend much more time collaborating with students, doing research, and just plain thinking. New working conditions, methods of assessment, and attitudes regarding curriculum are necessary. MLC teachers continue to improve the educational culture of the school as long as they are challenged and supported in their activism. A progressive educator is either empowered to shape her classroom environment or is a slave to the intentions of others.

There is a nagging belief among many teachers that constructionism, Logo, freedom, respect - whatever you wish to call it - is appropriate only for the students who have demonstrated educational achievement in the traditional ways. These teachers also believe that while they are capable of teaching in a constructive environment, the majority of their colleagues are not. This belief structure leads to depriving many students of potentially rewarding experiences and prevents more teachers from better-serving their students.

A concrete example of how this thinking manifests itself is in the way mathematics and Logo are treated in MLC's junior secondary school (grades 7-8). The standard syllabus is still followed, without enough concern for the new insights the students have as a result of their Logo-use. A syllabus of conservative teacher-conceived LogoWriter projects are assigned each year and teachers are given solution sheets for the assignments. It is amazing how quickly the solutions given to well-meaning mathematics teachers find their way into the students' projects. The primary purpose of using LogoWriter in the domain of mathematics is for the learner to confront intellectual obstacles that need to be overcome. Learners need time to develop such strategies. Handing a student a solution sheet prematurely prevents the student from mathematical understanding any deeper than that derived from "full-frontal teaching" and the student is also unlikely to gain any programming fluency. Teachers are often too concerned with covering curriculum, student "success," and the calendar.

This is understandable. No adult wants to see a child fail, although we create such opportunities with regularity. When a seventh grade teacher can not trust what the sixth grade teacher does and the eighth grade

teacher does, they must reinvent the subject each year in a teacher-centered way. The two seventh grade girls designing a LogoWriter tennis game are exploring many sophisticated mathematical concepts at an appropriate time for them, but a teacher of 30 kids who teaches something called, seventh grade mathematics, can not depend on serendipity. This teacher would feel more confident that all students would learn important knowledge and problem solving strategies if their entire school experience was one that respected tennis video games or student designed software tutorials on how to annoy other people. A school that creates these sorts of personal learning opportunities on a regular and ongoing basis, can depend on students learning most of the important mathematical concepts in a much more meaningful way, perhaps not always in the same sequence. The Western tradition of schools conspires against such meaningful learning.

> *The greatest enemy of understanding is coverage. As long as you are determined to cover everything, you actually ensure that most kids are not going to understand. You've got to take enough time to get kids deeply involved in something so they can think about it in lots of different ways and apply it - not just at school but at home and on the street and so on.* (Howard Gardner, 1993)

> *The entire point of all of the examples I have given is that computers serve best when they allow everything to change.* (Seymour Papert, 1993. Page 149)

Teachers are not to blame for this situation. Most work in an environment mired in archaic traditions and opposed to the "mega-change" discussed by Papert and underway at many laptop schools. What schools must realize is that *instruction leaves much more to chance than construction.* We have seen the disappointing result of traditional schooling's reliance on instruction. The issue is more complex than merely saying, "can we do any worse?" Logo-using teachers at schools like MLC have "lived" in environments in which students love learning. These professionals know that all children are capable learners. Their insights, ideas, and experiences must be trusted. Their learning stories and those of their students much be shared.

Teachers need to work in an environment that respects their personal insights and encourages routine to derive from their practical experiences. There is a menacing voice in the heads of many teachers that tells them to teach in other ways than they know are successful and rewarding. The pressing question becomes, "What sorts of schools can we design that will make the voice in our head supportive of our positive honest experiences as teachers and learners?"

Since educational computing has been so commercially driven, a visionary educational leader should be as wise a consumer as pedagogue. Any school interested in providing its students with the quality and the spirit of computing experiences available in laptop schools can begin to do so - even on a limited budget. A new mind set is required. Schools that can not afford a computer per student should begin thinking in terms of "milk-crate computing." The same money reserved for desktop computers, networks, and special furniture can be spent on notebook computers. The computers can be signed-out by a teacher or student and be used when and where they are most needed. The age of the Internet, cellular communications, and receiving a fax in your shirt pocket demands that school computing become more universal, personal, portable, and flexible. "Laptop-ready" applications like MicroWorlds, StarLogo and LEGO Control Lab provide a myriad of new opportunities for the personal construction of knowledge.

Einstein was once to have said, "Education is wasted on youth." I would like to play with this idea by proposing that, "Schools are wasted on adults." An honest appraisal of traditional schooling would show how schools have been created to meet the needs of adults: child care; passing-down traditions and morality; transmitting knowledge deemed valuable by a select group of adults. Schools across Australia are working to become a model for schools committed to creating rich environments that respect the learning of students and value the insights of adults. Logo and personal computing have contributed much towards this progress.

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