Columbia University Teachers College

Educational Change:
Effectively Implementing Technology
in the Classroom of the Third Millennium

An Integrative Experience submitted as required upon
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by

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ABSTRACT

My vision for the classroom of the third millennium is to foster knowledge building communities in partnership with students. In an age of worldwide, high-tech communications, we have become disconnected with the children. They are already citizens of the global community and they are waiting for the adults to catch up. School hierarchy must study how change is actually diffused and implemented in a systematic manner. We must be ever cognizant of the fact that we are dealing with humans who, by nature, resist change. Everett M. Rogers, in his scholarly work *Diffusion of Innovations (2005)*, has demonstrated that any change will happen in a predictable pattern. By understanding the social system of a school, identifying the "norms" of accepted behavior and recognizing that there are early innovators and early adaptors among us, we can more effectively begin to implement technology in the classroom of the third millennium.

EDUCATIONAL CHANGE: EFFECTIVELY IMPLEMENTING TECHNOLOGY IN THE CLASSROOM OF THE THIRD MILLENNIUM

The Concept of Change

Change. It is a word that continues to be bantered about in the Third Millennium by political candidates, product marketing specialists, health pundits, financial advisors, and educational reformers. Change is a word that motivated me to seek a new career in order to apply my expertise in computers to an area where I saw a great need for the effective implementation of technology. Rather than return to the banking industry, I decided to return to school at Columbia University Teachers College in order to earn the credentials to be able to convince educators that technology does indeed belong in the hands of students in today's classrooms.

When I began my studies in the Fall of 2005, I had an oversimplified viewpoint that the implementation of technology would be readily accepted, welcomed and intuitively recognized by administrators and teachers as obviously "needed". What I found during my three years of study and my yearlong internship in middle school classrooms was just the opposite. Instead, technology was feared, circumvented, and considered "extra work". I was quite surprised and realized that I had to "change" my strategies in order to successfully encourage teachers and administrators to embrace technology in the classroom.

A Discussion of Diffusion of Innovations

A pivotal resource during my studies at Teachers College is a book entitled *Diffusion of Innovations* by Everett M. Rogers. Luckily, I encountered this resource during my first semester in the course Technology and School Change. Once I read the

scholarly research compiled in the fifth edition of this book, the main elements of the process of the diffusion of any new idea into any group became clear.

The definition of diffusion, according to Rogers (2003), is "…the process in which an **innovation** is **communicated** through certain **channels** over **time** among the members of a **social system.** (p. 5) While communication is traditionally known as a process by which information is shared in a group, diffusion is a specific type of communication of a new idea and represents a type of social change. Rogers (2003) states, "Diffusion is a kind of social change, defined as the process by which alteration occurs in the structure and function of a social system." (p. 6) Rogers points out that the four main elements in the Diffusion of Innovations are:

The Innovation - "An innovation is an idea, practice, or object that is perceived as new by an individual or other unit of adoption (Rogers, 2003, p. 12)." In my work, the innovation is the integration of technology into the curriculum. There are many opportunities to integrate technology in the classroom. When I ask educators to list the technology that they have access to in the classroom, they usually enumerate hardware resources. One of my missions is to move away from listing hardware (PC's Laptops, handhelds, printers, Smart Boards, projectors) and instead encourage listing the software and internet resources that can be effectively implemented using the hardware to support and enhance curriculum. Examples of software are Inspiration, TimeLiner, Excel in PC and Mobile (handheld) formats, advanced aspects of Microsoft Word such as merging documents with databases, Internet resources such as mind mapping, collaborative spreadsheets and collaborative Power Point presentations, Wikis, WebQuests, etc.

Communication Channels – According to Rogers (2003), a communication channel is, "…the means by which messages get from one individual to another." (p. 18). Analysis of diffusion indicates that most people depend on subjective information about an innovation given to them by someone who has already adopted an innovation, rather than specific scientific data proving benefits or consequences of an innovation. The heart of diffusion is in the imitation within their social network of peers who have adopted the innovation. Rogers makes a distinction between homophilous individuals who have the same "beliefs, education and socioeconomic status" and heterophilous individuals who have differences in these attributes. Homophilous individuals are more likely to communicate effectively and the communication will be more rewarding to the participants. Rogers (2003) notes that, "One of the most distinctive problems in the diffusion of innovations is that the participants are usually heterophilous." (p. 19). An important ingredient, however, is that some heterophily be present such that the person acting as a change agent can provide new information to the group. Rogers also states, "Ideally, the individuals would be homophilous on all other variables (education, socioeconomic status, and the like) even though they are heterophilous regarding the innovation." (p. 19). Educators that I have met during my Internship might be homophilous in education and socioeconomic status, but I have found that educators teach within pockets of isolation. Science teachers teaching the same grade level very rarely share lesson plans or classrooms. I have observed islands of education with no opportunity to commiserate. Science teachers do not feel a kinship with literature teachers or math teachers. They do not share hardware or software. Very little is known about what is happening in the classroom next door. There are inherent problems within

the organization of schools which must be changed before technology can be integrated using homophilous communication. Through my courses at Teachers College, I sought to gain the homophilous aspects of teaching in order to effectively commiserate with teachers in the classroom. I am already homophilous with business peers in the banking industry. I needed to change my focus in order to gain the trust of educators, while at the same time maintain the heterophilous aspects of my technical knowledge in order to spread new knowledge about the integration of technology into the classroom.

Time – According to Rogers (2003), the element of time tracks the steps from the moment that an individual, "…passes from first knowledge of an innovation, to the formation of an attitude toward the innovation, to a decision to adopt or reject, to implementation and use of the new idea, and to confirmation of this decision." (p. 20). This Innovation-Decision Process is an information seeking phase which results in either the adoption or the rejection of an innovation. Time is one area in which teachers are in short supply. They have an extensive curriculum to cover within rigid class period times, laced with assemblies, classroom management issues and assessment all within a climate of standardized tests. I have witnessed teachers instructing at a gallop. When you come into the classroom and suggest that they implement handheld computers with data sensors to test and demonstrate actual transpiration from a plant leaf, they politely look at you with a lot of skepticism.

Rogers (2003) describes a distinct progression of time through which an individual examines an innovation. The five steps include, "(1) knowledge, (2) persuasion, (3) decision, (4) implementation, and (5) confirmation." (p. 20). Uncertainty about an innovation is diminished during this stage of information seeking and

processing. I have followed these steps during my internship when I approach a teacher with a new idea about integrating technology into the curriculum. As I went though these steps with a variety of teachers, I found the next element of Rogers' Diffusion Theory to be especially true. Not all individuals adopt at the same rate. In his discourse about "Innovativeness and Adopter Categories", he lists five classes of members of a social system. The teachers that I worked with in the middle schools during my internship could be categorized according to Rogers' groups:

INNOVATORS – Described by Rogers as venturesome, this group contains active information seekers about new ideas and who can cope with a higher level uncertainty about an idea.

EARLY ADOPTERS – Described by Rogers as respected by peers, is part of the "local" social system. They decrease uncertainty within the local social system about a new idea by adopting it and conveying a "stamp of approval".

EARLY MAJORITY – Described by Rogers as "deliberate", they are the opinion leaders of the social system. This is an important link in the diffusion process, because this typically makes up one third of all members of a social system.

LATE MAJORITY – Described by Rogers as "skeptical", and do not adopt an idea until most others in the system have already done so. This group is particularly susceptible to peer pressure.

LAGGARDS – Described by Rogers as "traditional" and tend to be suspicious of innovations and change agents.

Within his discourse about the time dimension of any innovation, Rogers also points out a third element of time in the Diffusion of Innovations. The Rate of Adoption

is defined by Rogers (2003) as, "…the relative speed with which an innovation is adopted by members of a social system." (p. 23). Most innovations, according to Rogers (2003), exhibit an S-shaped rate of adoption and are measured by the "…length of time required for a certain percentage of the members of a system to adopt an innovation." (p. 23). While I did not plot the acceptance of the integration of technology into the curriculum during this Integrated Experience for my Masters in Computing in Education, it would be interesting to conduct a specific survey into the adoption of one technology, such as handheld computers, into the curriculum of one school.

A Social System – This element of the Diffusion of Innovations is defined by Rogers (2003) as, "…a set of interrelated units that are engaged in joint problem solving to accomplish a common goal. (p. 23). Since Rogers has conducted and plotted the diffusion of innovations within peasant families in a Peruvian village, to medical doctors in a hospital, the social system can consist of any group which shares a common objective. This aspect of the diffusion of an innovation involves the social structure. It consists of the pre-existing formal patterns of relationships among the members of the group. It also consists of the informal structures of interpersonal relationships and who interacts with whom. The following statement by Rogers is one which I consider most crucial in my work. Rogers (2003) states, "The structure of a social system can facilitate or impede the diffusion of innovations." (p. 25).

Within any school, there is an official hierarchy of Principal, Administrators, and Faculty. Yet, in order to effectively integrate technology within the curriculum, one must observe the group to identify the "norms" of the school and, most importantly, who are the "opinion leaders".

The "norms" of the group are the established behavior patterns for that system. Norms in any system tell members the boundaries of behavior. Schools are social systems that have norms of behavior set by Principals, Administrators, and Faculty. If a Principal and their Administration set the integration of technology as a required behavior, then it still requires opinion leaders and change agents to foster this innovation. Opinion leadership in any system is a designation which is earned within the group. Rogers (2003) indicates that it is based on, "…the individual's technical competence, social accessibility and conformity to the system's norms." (p. 27). This person is at the center of the interpersonal network of a group and serves as a role model for imitated behavior by their group. They are in the position to exert influence.

Rogers (2003) identifies another type of individual who exerts influence on a system. The "change agent" is, "…an individual who influences clients' innovation-decisions in a direction deemed desirable by a change agency." (p. 27). The change agent is usually described as, "…professionals with a university degree in a technical field (Rogers, 2003, p. 28)." This usually means that the change agent is heterophilous to the social group, which I have already discussed as being ineffective in communicating the change to the social group. Change agents, according to Rogers, often utilize an aide who is more homophilous to the group. Even though I can readily identify myself as a change agent from Columbia University Teachers College, I can be more effective by approaching the group as a homophilous aide assisting the Administration in the integration of technology into the curriculum.

If a Principal, Administration and Faculty have been working together for more than one school year, it is likely that most members of this social system can readily

identify the opinion leaders of the group. Subtle strategy can enlist the help of these individuals.

Another key influence on the adoption of an idea within a social system is that innovations can be adopted or rejected by individuals or by the entire social system. Within a school, the District, Principal or Administrators might have required that technology be utilized in the classroom. But, I have observed that Districts will invest in hardware with generic software and dictate that technology be used in the classroom. Fifty thousand dollar science carts with handheld computers are placed in the science classroom and remain unused for an entire school year. Teachers have told me that their annual review contained directives to use more technology in the classroom, yet there is a gaping hole between this statement and the actual adoption of technology.

Is the Administration within a school providing the staff development necessary to enable the teacher to effectively implement the technology within the lesson plans of the teachers? Do the teachers have the help they need to receive the "leg up" necessary to modify traditionally teacher centered lesson plans into student centered, constructivist methodology to bridge the gaping hole that exists between directives and implementation? The following sections of my report attempt to answer these questions.

A Discussion of the New Meaning of Educational Change

Another work which influenced and refined my perception of the sustainability of change is Michael Fullan's Third Edition of *The New Meaning of Educational Change*. Fullan reinforces Rogers' themes when he states, "Neglect of the phenomenology of change – that is, how people actually experience change as distinct from how it might

have been intended – is at the heart of the spectacular lack of success of most social reforms (Fullan, 2001, p. 8)."

Fullan calls for a Learning Organization within the teaching profession which works as a community. He is calling for the social network, as described by Rogers, to set into motion what they believe is worthwhile. In any social network, however, it is crucial to have an infrastructure in place that can sustain the innovation being set in motion. Adequate support of teachers which creates time in their schedule to commiserate is a key ingredient to make the innovation transition to become the "norm".

Effective leadership is crucial to the success of any organization. In business, a catch phrase is, "the tone from the top." A CEO can set a positive or negative tone which permeates their organization. The Principal is the CEO of their school. The way in which any change is introduced by a leader of any organization can make or break the effectiveness and ultimate success of the endeavor.

Fullan (2001) identifies six leadership styles which can positively or negatively affect the climate of their Social System. "The two styles that negatively affected climate, and in turn performance, were coercive (people resent and resist) and pacesetting (people get overwhelmed and burnt out)." (p. 149). The four remaining styles which produce positive outcomes are, Authoritative (encourages teachers toward a shared vision), Affiliative (based on harmony within the group), Democratic (actively encourages input and ideas from the Social System) and Coaching (concentrates on the professional development of their staff). Fullan (2001) states, "It is always the thinking leader who blends knowledge of local context and personalities with new ideas from the outside who is going to do best." (p. 149). This statement reinforces Rogers theories of

knowing the Social System and capitalizing on working with the members of a group that are the innovators and early adopters to work toward changing the established behaviors of the "norm" to effectively implement change. The Principal of a school must know their social system and work with their teachers.

The role of the Teacher in the effective integration of technology is the subject of the next section of my paper.

The Teacher

Isolation of Teachers

If Roger's concept of a social network for adopting change is to be successful, then the teaching profession must be given more opportunities to function as a community. Fullan notes that the theme of "autonomous isolation" stands out in the working conditions of teachers. I have personally observed microcosms of instruction existing in school settings. There were little or no opportunities for shared lesson plans, shared resources or collaboration. Classrooms were little islands floating in the ocean of the school environment. Occasionally, the principal or other administrator might dock for a while to observe, and feedback was given just to that teacher and not in a collaborative setting. Fullan (2001) comments that, "Inside schools, teacher-to-teacher links for mutual assistance or collaborative school improvement were weak or nonexistent." (p. 121). Schools examined by Fullan (2001) were, "…characterized by isolation among teachers, limited teacher learning on the job, teacher uncertainty about what and how to teach, and low commitment to the job and the school." (p. 121).

The "norm", defined by Rogers as the accepted behavior of an organization, is one of solitary confinement of teachers. This current culture of schools severs any social

networking among opinion leaders of the faculty and the levels of faculty adopters of any innovation. The current social network of today's schools must change in order for the diffusion of innovations to occur. Fullan (2001) suggests that, "There is no getting around the primacy of personal contact. Teachers need to participate in skill-training, workshops, but they also need to have one-to-one and group opportunities to receive and give help and more simple to converse about the meaning of change. Under these conditions, teachers learn how to use an innovation as well as to judge its desirability on more information-based grounds; they are in a better position to know whether they should accept, modify or reject the change." (p. 124). With this statement, Fullan reinforces Roger's Diffusion of Innovation Theory that an innovation is communicated through certain channels over time among the members of a social system. We have therefore identified a change which must be made in the culture of teaching. Principals and Administrators must create more time in the teacher's schedule for common planning time within the faculty.

An example of the success of teacher collaboration was highlighted in a reading assigned during my Curriculum Theory and History Course at TC. In the book *The Power of Their Ideas*, Deborah Meier states, "The school's (Central Park East in Harlem) structure, from the placement of rooms to the scheduling of the day, is organized to enable teachers to visit each other's classes, to reflect on their own and their colleague's practice, and give each other feedback and support (Meier, 1995, p. 56)." During this course which was held during the Spring semester of 2007, our class met with the current principal of Central Park East who elaborated on the continued success of this type of collaboration among faculty.

What then, are some of the other obstacles that teachers must overcome in order to effectively integrate technology in the curriculum? An examination of teacher centered instruction is the subject of the next section of this paper.

Teacher Centered Instruction

Taking into account Fullan's description of the profession of teaching as "autonomous isolation", it is easy to see how teachers could adopt the role of knowledge bearers and the students regarded as receivers of the teacher's knowledge. The culture of the teacher's classroom has remained predominantly teacher centered for over a century. In his book *How Teachers Taught*, Larry Cuban examines the differences in the methods of teacher-centered instruction with the methods of student-centered instruction. The microcosm of the isolated, autonomous classroom is characterized by Cuban as, "Knowledge must be transmitted to young people; the role of the school is to develop the mind and instill social values; students learn best in well-managed, noiseless classrooms where limits are made plain, academic rigor is prized, and where rules are equitable enforced by the teacher; and the teacher's authority, rooted in institutional legitimacy and knowledge, must be paid respectful attention…They account for the perseverance in such teaching practices as reliance upon textbooks, little student movement, and a concern for tranquil classrooms (Cuban, 1993, p. 245)."

Authentic student-centered instruction allows the students to have a say in the selection of what is taught, how the topic is learned and is characterized by much more movement within the classroom.

Cuban's work, *How Teachers Taught* examines the classroom from 1890 to 1980. But, what stage of development were computers in 1980? In 1976, Steve Jobs and Steve

Wazniak had just marketed a small number of the Apple I personal computer. It was a far cry from today's desktop or laptop computers which are so prevalent in today's schools. When Cuban talks about student-centered instruction, he includes attributes such as student discourse on learning tasks greater than or equal to the teacher, students placed into small groups for collaborative learning, students choosing and organizing content, class behavior and penalties led by students and various instructional "stations" made available. It is in the "stations" aspect of student-centered instruction where technology fits well into place.

Policy decisions concerning student-centered instruction have been espoused by educators since the turn of the 20th century. Cuban sites two forms of early student-centered instruction. The one room school house was an initial example by virtue of its setting where cooperative work across several grade levels was ideal. Another form was espoused by philosophers such as John Dewey who advocated linking a child's life at home to what they learned in the "laboratory school" classroom setting. Dewey states, "Learning is active. It involves reaching out of the mind…Literally, we must take our stand with the child and our departure from him. It is he and not the subject-matter which determines both quality and quantity of learning (Dewey, 1902, p. 107)."

Educational reformers such as Pestalozzi wrote, "The man who lightly flutters about the outskirts of knowledge, rather than fortifying his understanding by quite, steady application, loses touch with Nature, forgoes real and constructive insight, and relinquishes that sense of truth that is alone receptive to true happiness (Pestalozzi, 1827, p. 19)."

Piaget's statement that "one comes to know the world through knowing oneself" (Confrey, 2006, p. 137) echoes Dewey's sentiment that learning is active. Pestalozzi, Dewey and Piaget are only three of the educational philosophers that have espoused student-centered, constructivist learning environments. Why then are most teachers still practicing teacher-centered instruction? Cuban (2003) suggests that, "Student-centered approaches, then, infrequently penetrated classrooms because of the unwillingness or incapacity of school officials to convert a policy decision or formal approval of an instructional change into a process that would gain teacher support for classroom adoption." (p. 246). In other words, the school officials did not diffuse the innovation properly in order to accomplish adoption of the change in philosophy by the teachers.

Communities of Practice

A Community of Practice, as defined by Jonassen (2003), "…is a group of people who share a common interest in a topic or area, a particular way of talking about their phenomena, tools and sense-making approaches for building their collaborative knowledge with a sense of common collective tasks." (p. 71). A faculty of a school can be a Community of Practice. This concept fits well within Roger's concept of "the norm" which is the established behavior patterns of a social system.

The theme of isolation, however, keeps reoccurring in my discussions with teachers and in my reading of scholarly resources. Jonassen comments, "Teacher isolation has long been an obstacle to the exchange of ideas and information the teaching profession. The current structure of our school system makes it difficult for in-depth interaction and collaboration to occur among teachers (Jonassen, 2003, p. 94)."

How, then, can a school move away from the "norm" of isolation and teacher-centered instruction to communities of practice and student-centered instruction? In their book *In Search of Understanding: The Case for Constructivist Classrooms*, Jacqueline and Martin Brooks (2001) state, "Constructivism stands in contrast to the more deeply rooted ways of teaching that have long typified American classrooms. Traditionally, learning has been thought to be a 'mimetic' activity, a process that involves students repeating, or miming, newly presented information (Jackson, 1986) in reports or on quizzes and tests (Brooks, 2001, p. 15)."

Instead, Brooks proposes that implementing problems which are relevant to the student is a basic tenet of the constructivist classroom. Brooks uses the word "invite" to describe the actions of the teacher and the knowledge community to set the stage for framing the learning that is about to happen. The students do not sit down in the classroom with an innate interest in photosynthesis or direct objects, but most students can be coached by the teacher to construct their own understandings of these topics.

Constructivism with a "v"

Jean Piaget, a Swiss psychologist, is considered the founder of "constructivism". Piaget, "…viewed constructivism as a way of explaining how people come to know about their world (Brooks, 2001, p. 26)." Piaget's early research, "…proposed that children progress through four stages of increasing intellectual sophistication: sensory motor, preoperational, concrete-operational, and formal-operational (Anderson, 2005, p. 423)." Piaget recognized a concept called "conservation" which is the knowledge that is preserved and retained by a child through his various stages of intellectual sophistication. By conserving knowledge, the student is able to construct new concepts by building on

retained learning. As teachers, we are always concerned about how much our students will retain what we have taught them. By being aware of the concept of conservation, as proposed by Piaget, we can turn our focus from teacher-centered instruction to student-centered construction of knowledge. Each individual student comes to our classroom with a basis of knowledge that they have retained from prior learning. This prior learning can come from our own teaching, the teaching of our co-workers, concepts carried over from the home environment, and many other influences in a child's life. The constructivist classroom allows each student to continue to build knowledge, and therefore conservation, through authentic lesson plans and an active discourse in a knowledge building community.

By examining Piaget's concept of conservation, we can come to a better understanding of the students' construction of knowledge and be better able to relinquish teacher-centered instruction and adopt student-centered pedagogy.

Conservation during the sensory motor stage, framed by Piaget to be between birth and twelve months of age, involves the child's ability to recognize the permanence of an object. During the sensory motor stage, an object ceases to exist if the child cannot see the object. While my own daughters were between the ages of birth and twelve months of age, I used to think that they threw the same toy over the side of the high chair in order to see how many times Mama would pick it up. Now that I have read about Piaget's sensory motor stage, I realize that they were developing an understanding of the permanence of an object. If the toy disappeared over the side of the high chair, it reappeared again when Mama tirelessly picked it up.

At about the time a child turns six years old, Piaget identifies a change when the child transitions from the preoperational stage (two years to seven years old) and the concrete-operational stage (seven years to eleven years old). Before the age of six, children's ability to reason is flawed. Before the age of six, my oldest daughter was convinced that she would be sucked down the drain of the bathtub if I let the water out while she was still inside the bathtub. When I questioned her about this, she indicated that if she saw it happen on a cartoon, then it could happen to her. I reassured her that she was too big to fit down the drain of the bathtub and what happened in cartoons was not based on reality. Looking back now, she was not able to reason between real life and animation. She had to develop her sense of reality through questioning and revising her understanding.

While it has been argued that the age of six also coincides with entry into school, Piaget has demonstrated this ability to reason with the example of the "conservation of quantity". Piaget examined how a child , "…develops the concept of quantity and learns that quantity is something that is preserved under various transformations, such as moving …objects (Anderson, 2005, p. 425)." An example of this type of cognitive development is placing the same number of objects in two rows which are lined up. If a child is asked to identify that the two rows contain the same number of objects, then the child will usually reply that they do. If one of the rows is then compressed to a small stack next to the row that they just evaluated, the child usually replies that the quantity of objects in the shorter stack is less. When asked to count the objects, the child is surprised to find that the groups of objects are indeed identical. Once the child reaches the formal-

operational period, from eleven years to adulthood, the ability to "…understand conservation reaches new levels of abstraction(Anderson, 2005, p. 427)."

It is important for math teachers to understand the students' developing ability to conserve the quantity of objects. Once the teacher can determine if each student is able to understand quantity, then they would be better able to help the students construct their knowledge of how to perform mathematical operations. Hands-on, authentic use of manipulatives to count, add and subtract will form the basis of knowledge for developing good math skills. We cannot make the assumption that the hands-on activities are prevalent in every classroom. This reflects back to the theme of isolation in the teaching profession. If two math teachers of the same grade level are not collaborating about methods, one might utilize hands-on, student centered instruction, while the other might not. Both of my daughters were taught math at school through the use of a number line and rarely were give access at school to manipulatives. I personally purchased manipulative kits and supplemented their math lessons at home.

The challenge then is to change the "norm" of teacher centered instruction to creating environments in which students are given the time to think, ponder, explore, manipulate and construct their individual knowledge. This constructivist, student centered instruction can be "sold" and diffused to teachers who are reluctant to change by being made aware of theories such as Piaget's conservation of knowledge. This theory is one of many cognitive philosophies which could be shared and discussed through communities of practice among the social network of teachers in a school. Can we make the assumption that teachers have covered cognition during their own studies? By

creating opportunities to share knowledge within the faculty of a school, we can diffuse the innovations of student-centered instruction.

It is this concept of deep understanding which has been expanded upon by other scholars, such as Seymour Papert, developer of the LOGO programming language. Papert, who studied with Piaget, began to expand upon the cognitive concepts established by his mentor. Papert took Piaget's concept of Constructivism and expanded upon it to develop his own concept of Constructionism. Papert's Constructionism is another example of student-centered learning which can be adopted by teachers as the "norm" in the social system of schools.

Constructionism with an "n"

Papert's constructionism, "…views learning as building relationships between old and new knowledge, in interactions with others, while creating artifacts of social relevance (Kafai, 2006, p. 35)." I am particularly interested in Papert's work because the roots of my knowledge are imbedded in programming. During the year 1979, I was completing my undergraduate programming classes in BASIC and FORTRAN. This is the same time that Papert was introducing his Logo programming language as a "thinking and learning" tool in schools. Students had to enter commands to cause a graphic turtle to move according to the student's instructions. The children could plan the path of the turtle using their own bodies, then input computer commands to recreate their actions on the screen. The students then had the opportunity to "debug" their code when the turtle did not perform as expected. Three separate, but interrelated skills had to be acquired. The students had to become adept at programming, mathematics and "learning to learn".

Papert's Logo programming is one example of a tool that was used to allow students to construct their understanding of a subject such as math. I have read articles concerning the debate over the benefits or drawbacks of the "carry over" skills of Logo. Having personally programmed for many years, I can attest to the "carry over" benefits of learning a programming language. Programming teaches you how to think in the least number of steps. It teaches you how to un-complicate your thinking processes so that you can eliminate unnecessary data to arrive at the correct solution in a timely manner.

How can teachers in today's classrooms create lesson plans which incorporate knowledge building while interacting with others to create "artifacts of social relevance"? I was able to implement one such lesson plan during my internship at MS256 on West 93rd Street in Manhattan. The Legacy software shell, designed and implemented by a team at Vanderbilt University, was developed to provide a framework for the construction of knowledge in the classroom. Schwartz and his fellow authors provide the Legacy framework which is both constructivist and provides a built in opportunity to create a community of practice. The Legacy team states, "In our experiences, case-, problem- and project-based learning are most effective when teachers, students and other interested parties form "learning communities" where there is individual accountability yet people collaborate in order to achieve important objectives, and where there is access to expertise that often lies outside the classroom community (Schwartz, 1999, p. 3)."

Legacy Instructional Design

The Legacy Instructional Design model is a framework that creates a flexible learning environment through which the teacher can invite students to form a community of practice in order to construct knowledge.

By my own definition, flexibility is the willingness to sustain calculated change within a well established framework. I derive that definition from my years of project management in the data processing industry. In order to effectively run a project, one must have clear boundaries as to what is within the project's framework and what is outside the scope of the current project. Any project, including a lesson plan in a classroom, can become too big and unmanageable if the project leader (the teacher in the classroom) lets their "community of practice" (their students) expand the project (lesson plan) beyond the scope of the intended product (the learning goal). This happens frequently in business and, as project leader, one must have the "big picture" in mind. New projects or lesson plans can be spawned into their own structure if an idea is too big for the current project and merits its own framework. The answer is never, "No", but instead, "Lets examine that idea within its own framework."

Flexibility is a key word in the constructivist classroom because the teacher builds a framework including paths that the students can take in order to build knowledge. The teacher can allow the addition of a related idea to become part of the lesson plan to construct new knowledge. During my course at TC entitled Instructional Design of Educational Technology, we learned about the Legacy Design Model which is an example of a flexible learning environment which can be utilized by teachers to create a flexible framework for learning.

I had the opportunity to implement the Legacy Design Model during my Internship with Reach the World at MS256 on West 93rd Street in New York. One of the science teachers that I worked with, Deirdre McEvoy is definitely an "Innovator" in Rogers' structure of adopters. She was willing to actively seek new information about an

idea and could cope with a higher level of uncertainty about the new concept. As Change Agent, I suggested that we try something completely new in her classroom by developing a hybrid of the Legacy Design Model using a wiki, a blog and various resources on the internet as a framework for inquiry by her students in the study of Astronomy. My work on the Legacy Design Model was done as a group collaborative effort with my classmates Rachel Connelly and Brian Apt during our Instructional Design of Educational Technology course at TC. The concept of a community of practice was being implemented in three levels. Our design team was the first level of a community of practice where we could develop and implement our understanding of instructional design through the use of technology. This online course really put the "distance" in "distance learning" because my classmates were located in Kentucky and Iowa. The second level of community of practice was Deirdre and I. She had indicated to me that it was a novelty to be able to "bounce ideas" off of another teacher. The third level of a community of practice consisted of the groups of students in the two eighth grade science classes studying astronomy. The whole process was both innovative and rewarding on all levels.

The Legacy Design Model integrates four key types of learning environments which allow flexibility in the classroom:

Learner Centered – Schwartz (1999) and his team describe this environment as one which focuses "…on knowledge, skills and attitudes that students bring to the learning situation." (p. 4). Deirdre identified an interest in Astronomy among her students. She was able to fit in an Astronomy unit within her prescribed science curriculum which coincided with my assignment within the Instructional Design course

to implement the Legacy Model in a real classroom setting. Deirdre and I had already implemented a wiki based science unit having to do with food and nutrition entitled Choice, Control, Change. The students had already enjoyed working collaboratively on wikis and knew the protocol for working in a group and taking turns editing the wiki. We found that the behavior in the classroom improved when technology, such as the Internet on laptops, was being utilized. The students were enthused about the new astronomy unit.

Knowledge Centered Environments – Schwartz (1999) and his team describe this environment as one which focuses on "…knowledge that is organized around 'core concepts' or 'big ideas' that support subsequent learning in the disciplines." (p. 4). The "big idea" we developed was, "What is your place in the universe?" Legacy has a cyclical structure to its design. Students move from a starting and ending point called "Look Ahead and Reflect Back". In the Legacy software, this was a virtual notebook that the teams of students could write down questions and answers to the learning that was evolving. Since our Legacy was a hybrid, we developed a Science Blog where students could post their questions about stars and the universe. A series of three progressively complex "Challenges" share the same steps of "Generate Ideas", "Multiple Perspectives", "Research and Revise", "Test Your Mettle", and "Go Public". The metaphor of successively higher and more challenging mountains was used in the original Legacy Design Model at Vanderbilt. Since we were implementing an astronomy unit, we used three progressively bigger sizes of the space shuttle as our metaphor for the challenges. Each Challenge contained activities in the form of links set up by Deirdre and me which would enable them to step through constructing their understanding of their place in the

universe which is our main, "big" idea. The students begin by clicking on the link which takes them to an online movie entitled "Powers of Ten". *Powers of Ten* explores the relative size of things from the microscopic to the cosmic. The 1977 film travels from an aerial view of a man in a Chicago park to the outer limits of the universe directly above him and back down into the microscopic world contained in the man's hand. *Powers of Ten* illustrates the universe as an arena of both continuity and change, of everyday picnics and cosmic mystery. Then, the students were asked to click on the Google Earth icon on their desktop to "fly to" their school at 154 West 93rd street in New York. Then, the class is asked to "fly" further out for a progressive view of Manhattan Island, New York State, United States and North America. You could actually witness the students constructing their knowledge. When we demonstrated the use of Google Earth which was projected on a screen at the front of the classroom, the students constructed their "cosmic address." Their correct cosmic address is 154 West 93rd Street, Borough of Manhattan, City of New York, New York State, United States, North America, Northern Hemisphere, Earth, Solar System, Milky Way Galaxy. Many of them jumped straight from West 93rd Street to Earth. Others did not realize that Manhattan is an island. Others never noticed the shape of New York State or the location of the other boroughs of New York. A simple paper postcard was created as the "artifact" as per Papert or "legacy for the next class" as per Schwartz. Then, we encouraged the students to "fly to" any destination on Google Earth. We had expected them to "fly to" Yankee Stadium or other famous landmarks. We were amazed to find that most of them, being from immigrant families, flew to their country of origin such as the Dominican Republic or Albania. The Legacy Design model was

flexible enough to allow us to have the students explore topics which interested them while still staying within the framework of the astronomy lesson.

Assessment Centered Environments – Schwartz (1999) and his team define this environment as one which, "…helps students' thinking to become visible so that both they and their teachers can assess and revise their understanding." (p. 4). Deirdre and I created several worksheets which we made available both in paper and wiki format. These interim worksheets provided us with a benchmark of how the students were grasping the concepts.

Community Centered Environments – Schwartz and his team define this environment as that which, "…capitalize on local settings to create a sense of collaboration – both among students and with other members of the community (Schwartz, 1999, p. 4)." We had a unique opportunity to expand our community of practice within the framework of the Astronomy lesson because my TC Project Team included Rachel Connolly, who is the director of the Moore Observatory at the University of Louisville and the Mt. Kent Observatory in Australia . Rachel, together with Dr. John Kielkoph, also of the University of Louisville, answered the students' questions about stars and the universe in both blog and real time internet conversation via Adobe Connect software.

Through a constructivist learning environment, such as Legacy, teachers can develop a lesson plan which will encourage active inquiry and build upon the students current perceptions. Brooks (2001) states, "Learning is enhanced when the curriculum's cognitive, social and emotional demands are accessible to the student. Therefore, some sort of relationship must exist between the demands of the curriculum and the

suppositions that each student brings to the curricular task." (p. 69). Deirdre and I witnessed that the students did not have a clear understanding of their whole universe address. We had to build upon their knowledge, especially since the majority of our students are from minority and immigrant communities. Living in a city environment, they clearly have not been adequately exposed to a clear night sky with a great view of stars and constellations. Being children of lower income families, they most probably have not had the opportunity to get an aerial view of the earth from the window of an airplane. When we asked them to "fly to" anyplace on the earth, most of the chose the country from which their family emigrated. Their knowledge base was very different than we had initially considered.

The Student

I have identified and examined the role of the innovation, the key elements of successful change, the leaders and teachers in the educational community. It is now time to turn my focus on the purpose of our profession, the knowledge building of our individual students. It is with great delight that I have met and interacted with the eighth grade science students at MS256 and the special education students at MS258. I love talking to the kids and interacting with them. Deirdre McEvoy and Terry Peters create classroom environments which are creative, informative and caring. Both teachers were definitely isolated before I arrived as intern to their classrooms. Deirdre and Terry espouse student centered learning environments and can be considered Innovators in Rogers' scheme of adopters of an innovation.

It has been interesting to be involved with groups of students who have a very different socio-economic and educational background than I have personally experienced.

My own experience has come from a very homogenous white, upper middle class, Catholic environment with many educational opportunities at my disposal. I found myself having to strip away all of my assumptions based on my personal background and try to become in tune with our students.

The following demographic analysis is an excerpt from our final group report for the Instructional Design of Education Technology course. The report described the implementation of the Astronomy Legacy Instructional Design Model in two eighth grade science classes at MS256:

"Our group worked with two eighth grade classes at MS256 which is located on West 93rd Street in the Borough of Manhattan. The fifty students are in Ms. Deirdre McEvoy's science class. MS256 receives Title I Funding and was recently taken off the New York State list of Schools in Need of Improvement. The demographic profile of MS256 is as follows:

Total Student Population: 170

- Female 52%
- Male 48%
- Ethnicity
    - Asian and Others: 3%
    - Hispanic: 34%
    - Black: 58%
    - White: 5%
- English Language Learners 2%
- Eligible for Free Lunch: 71%

The students frequently exhibit behavior problems which make classroom management a big issue. Student behavior frequently impedes instruction. The students can be broken up into three groups, those who are obedient and want to learn, those who deliberately cause distractions to disrupt instruction, and those who are distracted by the uproar. The average age of the students is fourteen years old. We have two students in this eighth grade who are sixteen and seventeen years old (Group One, 2007, p. 4)."

I also assisted Terry Peters in the implementation of technology within her Special Education class at MS258. This school has a similar demographic structure and is comprised of special needs students in the sixth, seventh and eighth grades. All of my assumptions as to how students learn were put aside as I witnessed the unique challenges presented in this classroom. Through my internship with Reach the World, Terry and I provided her class with opportunities to follow the voyage of the Makulu as it visited various locations on its voyage to Africa and the Caribbean. Terry was able to take certain aspects of what was being discussed by the crew via their online logbooks to teach her class various concepts which fit within her curriculum. Initially, Terry was skeptical if technology could be introduced successfully to her special needs class. Being an Innovator, however, Terry took the extra risk to try something new. She had a Smart Board in her classroom which she underutilized. Through various sessions together, she and I were able to utilize the Smart Board to construct lessons about the voyages of the Makulu and its various destinations. The children loved the vicarious adventure and Terry was able to implement technology in the process. The Smart Board provides a unique tactile opportunity which fit well with her students. She was able to teach simple

concepts of opposites such as small and big by having the students come up to the Smart Board and touch the Gallery components to drag the object from a small to big size.

Terry and Deirdre are Innovators who were willing to take risks to try to implement new lesson plans to support their student centered beliefs. In observing their schools' social structure, however, the norm is one of isolation with little opportunity to diffuse the innovation of the implementation of technology to any potential Early Adopters.

Student Centered Instruction

In her book *Teaching with Technology*, Judith Sandholtz (1997) and her fellow authors state, "…one of the most significant outcomes of the use of computers in the classroom has been a change in teachers' roles from the 'traditional presenters of ready-made knowledge' to facilitators of student learning." (p. 10). This is a recognized need in a shift from teacher centered to student centered instruction when learning is perceived as a personal journey made by students in the pursuit of conservation and retention of knowledge. The students' foundation of ideas is built brick by brick as long as teachers are willing to make the change from the role of expert to role of coach and a partner in learning.

When looking for a foundation of philosophy with which I can base my argument for student centered instruction, I always seem to reach for my books by John Dewey. In his book *Experience and Education*, Dewey states, "…the fundamental unity of the newer philosophy is an intimate and necessary relation between the process of actual experience and education. If this be true, then a positive and constructive development of

its own basic idea depends upon having a correct idea of experience (Dewey, 1938, p. 20)."

During the time of my three years of study at Teachers College, I have often quoted David Jonassen in his book *Learning to Solve Problems with Technology*. Jonassen (2003) states, "…people have always found ways to communicate with each other in order to support community goals and activities; they have overcome obstacles and used considerable ingenuity in doing so. If working and learning together in communities is so natural, why do schools individualize learning and make its outcomes competitive among students?" (p. 70). Instead, Jonassen suggests forming Knowledge Building Communities such that students can work together toward a common learning goal. The teacher can foster camaraderie and shared purpose rather than creating grade-fueled competitions. One solution to fostering this teamwork is the Knowledge Building Community.

Knowledge Building Communities

Jonassen (2003) states, "When students own the knowledge, rather than the teacher or the textbook, they become committed to building knowledge rather than receiving and reprocessing it. Knowledge Building becomes a social activity, not a solitary one of retention and regurgitation." (p. 72). This type of community answers Rogers analysis of a social system in that a classroom full of students is a social network in and of itself. Anyone who has ever observed children, inside or outside of a classroom, knows that children seek out their peers and a definite social hierarchy of innovators, early adopters, early majority, late majority and laggards becomes evident. Curriculum is an innovation to students. By tapping into what we know about groups, we

can modify the delivery of this innovation to our microcosm of the social system of the classroom. By forming a Knowledge Community, we can utilize the natural tendencies of the students to be social among one another. We can identify the innovators and spread knowledge to the rest of the social hierarchy of the classroom.

During my internship at MS256, Deirdre and I implemented a lesson plan using a wiki during a science unit concerning food intake and healthy choices entitled Choice Control Change, which I have previously described. We observed that some students had a very quick response to learning to work as a group and edit the wiki with their collaborative answers. We asked the students who quickly grasped and enjoyed the editing techniques to become "Technology Assistants" so that we could have help in teaching the methodology to their fellow students. The new assistants were both proud of their new designation and enthused about helping. Behavior issues which had been prevalent in the classroom before the lesson improved. Students who normally would not interact with certain other classmates overcame those barriers and communication between groups improved. We gave the students "ownership" of their learning. Jonassen (2003) states, "Ownership is the key to constructivism. Ownership usually entails commitment, pride and satisfaction." (p. 177).

Students also learn very powerful "carry over skills" when they take part in Knowledge Building Communities. Additional benefits of learning to work collaboratively lead to the ability to work effectively with one another, to organize resources and perfect their presentation skills.

Sandholtz (1997) also notes that, "The benefits of technology integration are best realized when learning is not just the process of transferring facts from one person to

another, but when the teacher's goal is to empower students as thinkers and problem solvers." (p. 176).

Conclusion

I believe that the students in the classroom of the Third Millennium are ready for a student centered education. It is the adults who cling to the "norm" of students as separate assessable vessels of knowledge. The children are ready. They are waiting for the adults to catch up.

The Teacher

New Uses of Existing Software

While I was an intern at MS256, Deirdre and I were commiserating on how we would implement technology in a science unit which examined water quality. Reach the World had sent a crew to Africa and Deirdre had emailed them to take water samples from four rivers in Africa. The crew of the Makulu took samples of water from Oyster Creek in The Gambia, Gibraltar, and "Hann Plage" in Dakar Senegal and the Agadir in Morocco. The water was tested for coliform bacteria, nitrates, turbidity, dissolved oxygen, phosphates, pH and temperature. With this much data, it made sense to create a spreadsheet.

The Excel spreadsheet software, originally released in 1985, was marketed as a tool to crunch numbers in the financial industry. It is, however, a very powerful tool to analyze any numbers in spreadsheet or graph formats. Instead of teaching the students how to set up an Excel spreadsheet, we devised a template which contained a spreadsheet with columns naming each of the rivers (including a clean river for comparison) and rows representing each water quality test. A "knee jerk" technology unit would traditionally

start with having each student construct a new Excel spreadsheet. Since we wanted to make sure that the students had the time to analyze the data, we delivered a template via zip drive of a "zeroed out" spreadsheet so that each student could input and analyze the science data. We wanted to use a traditionally math oriented tool in the science classroom. The students were given the raw data collected by the crew to input into the correct column of the spreadsheet. Deirdre and I imbedded hyperlinks to internet sites under each of the water quality test name in the spreadsheet which would explain the presence of coliform bacteria, nitrates, turbidity levels, consequences of low levels of dissolved oxygen, presence of phosphates, optimum levels of pH and the effects of change in temperature on water. The students input the data into the appropriate column and then were taught how to graph the results. Graphing enabled them to see a visual representation of the negative effects of various substances on drinking water. By comparing the rivers to an example of a clean river, the impact of the lesson was visible. The students learned about clean drinking water using a "hands on", real life example. Authentic learning was enabled in the classroom. Deirdre and I believed that, by using the timeline of the lesson wisely, we were able to deliver the opportunity for the students to construct their knowledge and ponder over really understanding what it means to have poor drinking water in other parts of the world.

In the classroom of the Third Millennium, teachers can step beyond traditional uses of software and internet sites in order to provide the tools necessary to deliver lessons to students for the purpose of thinking about what is being taught.

The Internet

The Internet, as far as I am concerned, is a candy store of opportunity for teachers. Before they enter your classroom, students have already been to all of the sites that you do not want them to visit. Today's students, even the lower income, minority students who I interacted with at MS256, are very technology savvy. The classroom was equipped with wireless laptops which we distributed to deliver our technology based science lessons. The NYC BOE filtered wireless network was quickly circumvented by the students who knew how to populate the list of area wireless networks. They quickly hopped onto the unsecured Linksys router in the neighborhood and were surreptitiously viewing My Space. You do not need administrator privileges on the laptop to populate the available wireless network screen. The kids know this fact. Classroom management has entered a new phase. The students must be instructed not to change the wireless configuration of the laptop to visit sites other than what is prescribed in the lesson plan. "POS", parent over shoulder, a common code in instant messaging must be extended to, "TOS", teacher over shoulder. There isn't a better substitute for classroom management in a constructivist, "stations" environment.

BLOGS, WIKIS, WEBQUESTS AND MIND MAPPING

The teacher can "contain" lessons on the internet through the use of Blogs, Wikis and WebQuests. I have already described the virtual science notebook within the Astronomy Legacy unit. By using a blog, the teachers, students and remote experts could all share knowledge in the same place. Students could access the blog from school or home to review answers posted to their questions.

I have developed another Blog for a literature unit as part of my coursework during the Cognition and Computing course at TC. This Blog, entitled American Heritage, could also serve as a Social Studies constructivist environment. I was compelled to write this unit because of my then sixth grade daughter. She came home with a reading assignment based on an excerpt of *The Bracelet* by Yoshiko Uchida which is a real life story about the author's experiences during the internment of Japanese-American citizens during World War II. I asked my daughter if her teacher had explained anything about this sad chapter in American history. As it turned out, the teacher had not even mentioned the bombing of Pearl Harbor or any other background information of the story. The story was being read in a void and homework questions were isolated to how the character felt about losing the bracelet, not about the bigger picture of forced incarceration of a segment of our population. I created this blog as a place where I could post links to pictures, video and other informative resources for a student to broaden their knowledge of World War II and the circumstances which Yoshiko Uchida and her family had to endure. I even found online resources containing the detainee's home videos of the internment camps.

The blog encompasses many carry over techniques which the students can utilize in other classes. Posts to the blog encourage proper writing skills with links to Visual Thesaurus to improve vocabulary. References to keyboarding shortcuts teach the students how to copy and paste their own links into the blog, tips on how to verify resources, use of search engines such as MetaCrawler to research topics all add to the basis of knowledge that the students can carry forward.

I have already described the wiki that I developed to contain the Astronomy Legacy Unit. I created another wiki entitled [s][h][a][r][e] literature. The word share in brackets is the name of my overarching wiki which contains all of my shared lesson plans. I designed the literature wiki as a final project during my coursework in Computers, Problem Solving and Cooperative Learning. While I did not have the opportunity to implement this in a real classroom setting, I felt compelled to design this literature wiki for another reading assignment given to my then fifth grade daughter. She was required to read *The True Confessions of Charlotte Doyle* by Avi for her literature class. While her teacher did an excellent job in covering the book, it was all on paper worksheets. I decided to try the problem solving analysis of the book in wiki format. The main character of the book, Charlotte, is presented with a number of problems as she travels by clipper ship from England to Rhode Island. I placed the main problem solving "thinking map" on the first page of the wiki and then broke the class up into groups named according to the "watches" on a ship. Each "watch" page contained the same set of questions which were answered by group discussion and then editing of the wiki.

I have often maintained that vocabulary is more difficult if it is learned out of context. Instead of providing a list of vocabulary for the students to look up, I provided a wiki page for the entire class to edit entitled, All Hands on Deck. This is the actual vocabulary list that my daughter came up with while reading the book. The idea here is to have the whole class participate in editing a collaborative vocabulary list of words found in context. I have included a link at the top of the [s][h][a][r][e] Literature home page entitled wiki etiquette. The wiki etiquette contains common courtesies for wiki editing. An important concept for the students to learn is called the "logical lock". A

logical lock is important in wiki editing because websites such as Wikispaces has not been coded for managing editing conflicts. Sites such as Wikipedia contain software to recognize editing conflicts and help simultaneous authors resolve those conflicts. When an article is being edited on Wikipedia simultaneously by two authors located in any part of the globe, the software recognizes this and displays a resolution screen. The screen shows the two conflicting edits and prompts the authors to resolve the double edit. Also, Wikipedia offers section edits in the form of the [edit] button. Authors can edit separate sections of the same article without conflicting with one another.

As of the time of this writing, April 2008, Wikispaces does not have this type of sophisticated editing resolution. This is one of the main reasons why group work is so important when using wikis. By dividing the class into groups, this subset of the class can collaborate on the editing of their page. If two students in the same group are working at their respective computers from home, then a "logical lock" is used. At the top of the page, a line contained at the top of every wiki page is edited and save right away in order to "reserve" the page by a student to edit for twenty minutes:

Logical Lock: This wiki is currently being edited by (edit your name here) on (edit the date here) at (edit the time here). By editing and saving this line right away, the student must be observant when they access the wiki and estimate when their fellow student will be done with the edit, which is twenty minutes from the time they reserved the edit. The editor must reset the logical lock to its original state when they are done with their edit and save to open the lock to other editors. This teaches collaboration and respect for one another's work.

The wiki enables the teacher to create a constructivist learning environment and stay on track with a curriculum unit. Yet, the wiki is flexible enough to edit to augment the lesson if the students are curious about a related topic.

A WebQuest is another way that a teacher can structure a lesson while providing the flexibility needed for a particular topic. I had the opportunity to create a WebQuest during my Hypermedia and Education course at TC. Professor Magni challenged us to create an educational website as our final project for the term. This assignment coincided with my nephew Brendan's request to be his partner in learning during his Flat Stanley reading unit in his second grade class in Michigan. *Flat Stanley* by Jim Brown is a children's book which relates the travels of a boy named Stanley who gets "flattened" one day and travels in an envelope to various destinations. "Flat Brendan" was sent to me to learn about New Jersey. Instead of sending Brendan postcards and letters, I took Flat Brendan on various adventures in our area, photographed Flat Brendan on location and created the WebQuest, "Let's Learn About New Jersey." Links to facts about the state bird, counties in New Jersey and the Pascack Historical Society exhibit of Lenape Indians were placed on the website. The seven main elements of the WebQuest, originated by Bernie Dodge, are Introduction, Task, Process, Evaluation, Conclusion, Credits and Teacher Page all work together to provide a contained yet comprehensive body of information for the students to explore. Both Brendan and I received an "A". Teachers do not have to know how to create a website using Dreamweaver or HTML. Their school does not even have to have a website or administrator. Edublogs.com provides blog pages to educators free of charge, as long as it is being used for an educational purpose. One can easily utilize a blog or a wiki as a springboard for a

WebQuest. The change in thinking that I am trying to foster is there are many uses for software beyond the original intention of its creators.

Mind mapping is a prime example a concept which can have many uses. During our Astronomy Legacy unit, Deirdre and I wanted to have the children study constellations as part of their examination of stars. We used an online flowcharting website called Gliffy. The original intent of this website was to provide the user with virtual graph paper to construct a flow diagram. Traditional programming flowchart symbols are located on the side of the screen which can be clicked and dragged onto the virtual chart. I noticed that one of the basic shapes available for use is a five point star. Each student was asked to create a replica of their personal zodiac sign on a Gliffy diagram as part of an introduction to our stars unit. The students took the task very seriously a produced accurate "maps" of their constellation. We also provided access to the open source programs Stellarium and Celestia so that the students could study stars and planets in "3D".

The Student

In 1945, Vannevar Bush wrote an article for Atlantic Monthly entitled, "As We May Think." As Director of the Office of Scientific Research and Development for the United States during World War II, he called upon his fellow post-war scientists to turn their talents away from the science of warfare and toward assisting Americans in the collection of knowledge for the edification of their citizens. In his article, Bush states, "Consider a future device for individual use, which is a sort of mechanized private file and library. It needs a name, and, to coin one at random, "memex" will do. A memex is a device in which an individual stores all his books, records, and communications, and

which is mechanized so that it may be consulted with exceeding speed and flexibility. It is an enlarged intimate supplement to his memory." (Bush, 1945, p. 4). Bush was calling for an electronic body of knowledge which has become the Internet.

Laptops

Laptops and desktops can be thought of as the answer to Vannevar Bush's "memex" device. In 1945, Bush was thinking beyond the memex as being a piece of hardware. He was thinking of the device as being a tool though which a person can associate their present knowledge and construct understanding.

Students who I have worked with during my internship frequently ask me questions about different topics that interest them. These topics might or might not have anything to do with the current lesson plan. I had one student who is very interested in NASA and was asking how he could learn more about becoming an astronaut. Deirdre and I were able to post links to NASA.gov within the wiki page Generate Ideas. By doing so, we created a venue for the student to explore a website to not only examine questions within the lesson plan, but also questions which might fulfill students' dreams of becoming an astronaut. If the topic is completely outside of the lesson plan, then I usually gave the students the names of search engines such as MetaCrawler to research the topic after school. I never want to shut down a student's interest in something by indicating that they are getting off track of the lesson. I make a mental note of this interest for later use.

I believe that we make a mistake in sending students off to a new teacher from one grade to the next. We have just gotten to know them personally and then are compelled to pass them to a new "instructor". Schools should consider allowing teachers

to keep students for at least a three year period, such as middle school in sixth, seventh and eighth grades. I have observed that this is a time, as suggested by Piaget, when children from approximately the age of eleven years old reach a "formal operational period". They are able to conserve knowledge and think abstractly. If we move away from the teacher centered concept of the instructor as a body of knowledge to be delivered and toward a "coach" who will guide the students to assemble knowledge, then I believe we will have a positive knowledge building team of teacher and students.

The kids want to talk to us. They want to have a dialogue, a conversation. They have questions, but in the current setup of schools, those inquires become suppressed. I would like to place education into the hands of the students.

Handhelds

One way that we can place education into the hands of the students is though the use of handhelds with sensor technology. By connecting the handhelds to sensor devices such as humidity, heart rate, motion, and photo light gates to test velocity, students can vary their own experiments and graph results. There isn't an easier way to teach graphing than having the students actively change data, rerun experiments and view the results. Schools do not have to wait for one big "science fair" to implement the scientific method. This method can be applied authentically to produce real-time results. The teacher-coach can pose the big question and have the students work toward the correct solution by making modifications once they view the graph of their results. I believe that the fear which teachers usually have when new technology is being implemented will actually disappear. This trepidation on the part of the teacher will actually change to enjoyment during active learning. The students love these experiments. When I would

come into the classroom before a planning session with Deirdre, the students would stop me and ask, "Are we doing something with the computers today?" They actually look forward to class.

Verifiable Resources

Fear of technology and especially the internet not only exists among the teaching community, but also within the parent group who entrust the minds and care of their children to our schools. This fear is understandable because there is a lot of danger in the world today and we must learn how to navigate the World Wide Web together. This is precisely why we must teach our Knowledge Community, teachers and students alike, on how to be discerning users of technology. Not all data found on the internet is accurate. A subset of sites, such as chat rooms, can lure our youngsters down a dangerous path. But, as I have already mentioned, the students know those sites, such as My Space, and most of them are curious enough to visit those sites to see what the fuss is all about. They know how to circumnavigate our filter software, especially if the laptops are being used wirelessly in an urban setting. They simply jump on a neighborhood unsecured network.

The "norm" of the classroom must be reinforced to stay away from specified sites in the classroom. A key tenet of the constructivist classroom is having the students self-regulate and decide on consequences for bad behavior. Students will respect an atmosphere of fairness where all students abide by the same rules, especially if they are given a certain amount of control over their learning. By giving the students this sense of ownership, we are empowering them to learn.

If we want to teach students to properly evaluate resources, we must give them the tools to accomplish this task. Universities such as Georgetown offer a webpage

entitled Evaluating Internet Resources. This is a carry over skill and does not represent any authority on the validity of any one particular resource. Instead, it lists guidelines to help the Knowledge Building Community to judge content. The students must be taught to verify resources through corroborating information.

The Classroom of the Third Millennium

My vision for the classroom of the third millennium is to foster Knowledge Building Communities in partnership with students. In an age of worldwide, high-tech communications, we have become disconnected with the children. They are already citizens of a global community and they are waiting for the adults in their world to catch up. School hierarchy must study how change is actually diffused and implemented in a systematic manner. We must be ever cognizant of the fact that we are dealing with humans who, as Rogers has demonstrated, diffuse any innovation in a predictable pattern. By understanding our social system, identifying norms and the innovators and early adopters among us, we can more effectively begin to implement technology in the classroom of the third millennium.

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APPENDICES

Cognitive Map of Integrative Project