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UNDERSTANDING WHAT MAKES A 'GOOD INNOVATION'

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PSYCHOLOGICAL INVESTIGATIONS OF EDUCATIONAL EXPLORATIONS WITH TECHNOLOGY: UNDERSTANDING WHAT MAKES A 'GOOD INNOVATION'

By

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ABSTRACT

PSYCHOLOGICAL INVESTIGATIONS OF EDUCATIONAL EXPLORATIONS WITH TECHNOLOGY: UNDERSTANDING WHAT MAKES A 'GOOD INNOVATION'

By

Richard Eugene Ferdig

In this study, I set out to answer the question, "What makes a good technological innovation?"—an important mandate for our young field of educational technology. Drawing on an exploration of an innovation entitled, 'Got Milk?', as well as an in-depth literature review, I establish that a good innovation is one that consists of three "P's": pedagogy, people, and performance. I argue that this *deep psychological approach* helps us establish a more multi-layered and complete understanding of the impact of technology innovations.

In working to establish this model of a good innovation, and thus to learn more about the participants working with the innovation, I adapted an interview protocol from Dan McAdams (McAdams, 1995) that leads a person through the telling of their story. This narrative approach, initially used as a methodology to understand educational technology implementation, was used by the teachers and students to further develop their teliographies regarding life, teaching, and teaching with technology.

Understanding the elements of a good innovation is an important task for our young field. It allows us to revisit what we already know, ground what we are currently working on, and guide our future endeavors. The unintended outcome

of the positive use of the narrative methodology is also important as it offers the potential for a new approach to teaching teachers about technology. Implications for both of these points are drawn for teachers, developers, and teacher educators.

DEDICATION

In the fall of 2000, just as the proverbial light at the end of the dissertation tunnel was in sight, my grandmother passed away. I was reminded of her passing as I sat in my living room watching a movie (Mom would call it procrastinating). A character in the movie pondered the decisions she made in life:

> "I have the sneaking suspicion that I chose the wrong path. For the past ten years, I have struggled to achieve what I thought was most important in life. Now that I have reached those goals and achieved what I held most dear, I wonder what I missed along the way. I wonder if what I pursued really has any value."

I do believe that the path I have chosen has value—even if it meant not having more time with my loved ones. I have seen it in the faces of the teachers and students I have had the opportunity to share my education with. However, I must confess—there are still moments when I feel the need to be apologetic for being selfish with my time and my studies.

Therefore, I dedicate this dissertation to my family and friends who were so patient with me over the last ten years from B.A. to M.A. to Ph.D. Thank you for your sacrifice and support as I came to better know and understand myself and the world around me.

ACKNOWLEDGEMENTS

I am not sure when a person ever officially starts the process that leads to a dissertation. I suppose the impetus to attend and finish graduate school came from three sources: my faith, my family and my academic mentors. My faith got me through the darkest hour—times when I questioned who I was, what I did, and why I did it. I praise the Lord that I have fought the good fight, I have finished the race, and I have kept the faith.

My Mom and Dad, the people who planted the seed of faith, were supportive and nurturing in multiple ways. They ensured a home visit was filled with good food, opportunities for discussion, and gentle probing about the finish line. Even though my choices in life were new terrain for them, they acted interested as I explained what 'pedagogy' meant. I do not know if I will ever be able to fully explain the desire to attend graduate school; nonetheless, they cared because they knew I did.

Other family and friends were also self-less during this time. My sister, brother-in-law, and niece gave me time to unwind and roof their house in the process. My grandparents, aunt and uncle, and friend 'P' bought me a surprise package of external motivation towards the end of the campaign. And friends like Pawel, C-Lyn, Dan, Mike, and Ron kept calling even when I did not have time to return their calls. To reiterate what I stated in my dedication, my family and friends gave me the opportunity to be selfish—something I needed from them in order to attain this important goal.

Although the support of my family and friends was essential, I would not have completed this dissertation without the support of my academic mentors. I owe a debt of gratitude to D. John Lee, former professor at Calvin College where I completed my B.A. I first learned about the potential of narrative in his cognitive psychology course. John was willing to take some pedagogical risks and they paid off for the students who were willing to story their life. In a chance meeting later at Michigan State, he urged me to continue devoting my life to what I valued.

Dick McLeod and Leighton Price were two important faculty members as I transitioned to Masters study at Michigan State. I had temporarily set aside my interest in narrative to further explore my fascination with technology. Dick and Leighton were two of the first people to ever show me how to care about teachers and students in classes, regardless of the subject you were teaching. They both provided opportunities to get involved in the right things at the right time. I am grateful to both of them for their continued support.

In 1996, armed with strong interests and experiences in both technology and narrative, I began the final leg of the journey that led to this dissertation. There are too many names for me to list all of the people that have made this dissertation possible. However, I want to specifically thank six people. I became friends with King Beach and P. David Pearson as I was leaving Michigan State in 1997. I had convinced myself that the grass was greener on the other side of the fence. I was planning on attending a different university to focus my studies on narrative and the development of the child. King Beach helped me realize that

sometimes moving places only means moving sideways. Once I decided that King was right, P. David Pearson took me under his wing and showed me what it meant to be an academic who made a difference. He was instrumental in first getting me published and in the completion of this final degree.

In the summer after I decided to stay, I took a qualitative course from Steve Weiland. Although other people had believed in my *abilities*, Steve joined P. David in believing in the *ideas* I brought to our discussions. For the first time in my graduate career, I began to believe that what I had to say was important. It sounds cliché these days, but Steve challenged me to be different. He taught me the rules and then showed me how to break them so I could what I wanted to say in the way I needed to say it. I am not sure how Steve and P. David had the perseverance to help a 'techie' become an academic. However, I am indebted to the support they provided. Their encouragement and advice helped secure both Spencer Research Training Grants I received to fund this research.

I also wish to thank the other two members of my committee—Susan Florio-Ruane and Rand Spiro. Once P. David and Steve helped me set the course, Susan and Rand provided the scaffolding I needed to learn more about narrative and technology. Their feedback was priceless. Although I did not answer all the questions they asked along the way, they provided a lifetime of learning in a short amount of time.

I need to thank the newest of my academic and personal mentors, Susan Melnick. She nurtured my growth as I made the transition from graduate student

to outreach specialist. Her concern for my well being provided the space in which to complete this dissertation.

My faith, family, and mentors provided the impetus to propose, write, defend, and revise this dissertation. However, without Danielle and Elizabeth, it would have never come to fruition. Danielle was willing to let me scrutinize her practice every single day for three years, including the final year of dissertation research. Danielle defined what a teacher was, how a good teacher taught, and what it meant to keep the faith. Elizabeth shared everything she could by telling her story. She took a risk in letting people see the 'real' Elizabeth, and I could not have asked for more.

In sum, I hope and pray that the people who supported me see a part of themselves in this text. For truly, they have touched my life and I am grateful to them for their gifts.

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Introduction

What Do We Know About Technology and Education?

> The arrival of personal computers and, more recently, the connection of those computers to the vast resources of the Internet, offer the potential to dramatically change the educational landscape." (Microsoft, 1996, 15)
>
> Media do not influence learning under any conditions. (Clark, 1983, p. 445)

With the amount of research and research journals available on the subject, it may seem like we have established many 'facts' and 'truths' about technology and pedagogy. We have evidence that technology helps motivate certain children, particularly those with special needs (Bamberger, 1999; Englert, Zhao, & Ferdig, 1998). Technology provides students access to places and information they may not have had access to before (Hall, 1999). Students more productively navigate complex, ill-structured domains when they use tools such as hypermedia and multimedia (Spiro, Coulson, Feltovich, & Anderson, 1988). Add the available research to the enormous amount of time and money designated each year for technology implementation, and an outsider might be convinced we have gained many 'facts' and 'truths' about the role of technology in education.

More realistically, the 'truth' is that we are only just beginning to learn within and about the young field of educational technology (understanding the adoption, use, and impact of technologies such as computers in education). As can be expected, we have ten questions for every one answer. Why do certain

teachers adopt technology quickly while others refuse to implement it? Should every school have a computer lab or a laptop available for each student? Do media such as computers directly impact a students' educational development or is it merely the instructional design afforded by the medium? How much Internet access should students be given? Do technologies fundamentally change a teacher's practice or merely make it more efficient?

All of these questions can potentially be encapsulated by (and are superimposed within) the caricatured battle currently waged in the field of educational technology. One side of the divide consists of technology-driven educators soap-boxing the classroom-changing benefits of computer implementation. The other side is made up of technology critics voicing the concerns and warnings of yet another unjustified panacea for education. Although this dividing line is obviously more blurred and the differences more complex than portrayed in this story, the ideologies undergirding each side are very real in the academic literature and the policy decisions in our schools (Agostino, 1999; Berrien, 1998; Cuban, 1986; Oppenheimer, 1997; Reeves, 1999). Technology[1], whether seen simply as devices with a central processing unit (CPU) or most recently as the Internet and multimedia, is seemingly under scrutiny for some inherent abilities to help teachers teach, help learners learn, and to fundamentally change the social and educational context of classrooms.

Rather than taking sides in this debate (labeled a futile approach by Thomas Reeves in a keynote address at EdMedia '99 (Reeves, 1999), we return

[1] The dictionary (Webster, 2000) defines technology in numerous ways. For purposes of this dissertation, the word 'technology' will be used to refer to computers and their use in education.

to our original question—what do we really know about technology and education? I will argue in this dissertation that *to understand the role of technology in education is to recognize that technology and pedagogy are not and cannot be separated in educational technology.* Thus, the advancements made through educational technology research have afforded convincing evidence because they have addressed technology as a part of pedagogy.[2,3] Rather than defending or depending upon the intrinsic qualities of technologies, they have acknowledged the fact that technology (for education) is neither inherently good nor bad. Or, to paraphrase Norman (Norman, 1993): the good news is that technology can make us smart...the bad news is that technology can make us stupid. Admittedly, there are qualities of different types of technologies that can make them more or less useful for certain types of activities—a point that will be elaborated upon in this text. For instance, a smaller computer that children can hold and carry will allow for different types of interactions than say a desktop computer with a 21" monitor. Or, a desktop application that only allows five users at a time might limit the functionality in a high school computer lab. However, the point is that what makes a technology innovation good or bad does not solely reside in the technology itself. Rather,

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[2] Readers might be convinced that I am referring to local transfer. In other words, what we know about technology and education is only valid when it relates to a certain pedagogical instance. The argument would be that an innovation is good because the research describes technology implementation in a fourth-grade classroom (in Holland, Michigan) studying Shakespeare. Furthermore, it is useful because it can be transferred to other Holland fourth-grade classrooms that want to study Shakespeare. However, I am not referring to transfer between cases. I am describing educational technology research that focuses on technology in pedagogy rather than technology in and of itself.

[3] Not only has research addressed technology as a part of pedagogy, but it has also addressed it as part of a cultural system (which includes pedagogy). Nicolopoulou and Cole (1994), through the Fifth Dimension project, argue that the effectiveness of programs will depend on the integration of those programs within a framework of the institution in which it is introduced, not on the intrinsic qualities of the technology in isolation.

as I will argue in this dissertation, it is a complex process involving the technology, the personnel (innovators, educators, and learners), the pedagogy, and the relationships between the three.

Although variations of the ideas in this text are evident in the existing, relevant literature, this is an important point to clarify and reiterate for a young field such as educational technology. Educators, technologists, and psychologists have decried the lack of research to justify the onslaught of technology expansion in our schools. They argue that there is no firm evidence that media even impact learning, as evidenced by the history of instructional strategies such as radio and television (Cuban, 1986). These criticisms notwithstanding, the field of educational technology has made important advancements regarding the qualities of successful technology integrations and the support they need for implementation. Thus, along with the call for further research to validate the technologies and defend their high cost, we need to revisit what we already know and what we have yet to learn. In other words, as our young domain grows we must ground development of cognitive tools in what we know currently works.

A Multi-Layered Approach to Educational Technology

Understanding 'best practices' in working with technology and education through an exploration of the relationships between technology, personnel and pedagogy will help ground past and present research, as well as guide the field into the future with focused research rather than numbing debates. However, ensuring more structured and rigid examinations of technology use is not

enough. We need to ensure that the expansion of technology research encompasses the right kinds of questions—questions that incorporate assessments of the technology development, questions that address the types of human interaction that are necessary for implementations to attain predefined and unintentional goals, and questions that delve into the psychological nature of the relationships we have with technology.[4]

This is an important step as there is danger in the push that has been made for increased research on technology and its impact on learning. Specifically, educational technology research programs tend to focus solely on the cognitive domain in the relationship between technology and learning. This is not to suggest that measuring learning outcomes of technology use is an unnecessary or fruitless endeavor, only one with inevitable limits. There is a plain, one might say urgent, need for a more complete approach to research on technology integration.

The problem with the trend in educational technology (often situated in educational psychology programs) to focus solely on the cognitive domain is the disappearance of research addressing the relationship between technology and social and emotional development. Surveys of major refereed technology journals indicate an almost extinct population of articles relating to this affective domain (see Jones & Paolucci, 1998, for a complete review). A number of articles have attempted to break out of the cognitive domain by asking questions about perceptions, attitudes, and motivation in using technology (Cordova &

[4] Mark Windschitl also makes this claim, arguing for stronger research that poses more critical questions (Windschitl, 1998).

Lepper, 1996; Lepper & Hodell, 1989). Others have begun to explore the relationships that exist because of or with technologies such as computers. Sherry Turkle, for instance, provided evidence that some people actually adapt their personalities to the personas they develop and adopt in on-line communities (Turkle, 1995). Byron Reeves and Clifford Nass have asked us to rethink media such as computers as social actors in a media equation (media = life) (Reeves & Nass, 1996). However, as highlighted by the aforementioned surveys on educational technology research, these types of studies are becoming more and more rare.[5] Studies like these are leading the way for creating a new set of research tools, but we must continue to focus on gaining a more complete psychology of technology.

Clifford Geertz argues that we need "thick descriptions" in order to better represent and understand human experience (Geertz, 1983). And in his famous essay "Deep Play" (Geertz, 1973b), he supplies a timely metaphor for a new field like educational technology. Applying this metaphor of "depth" to educational technology essentially means opening it up to all of the tools available to us as educators and psychologists rather than just technologists. There are a number of psychological questions that, although normally associated with developmental psychology and psychoanalysis, may prove fruitful in our discussion of a "deeper" educational technology. Questions include the role of emotions through technology, mediating relationships with technology, and sense and meaning-

[5] Jones and Paolucci (see (Jones & Paolucci, 1998) surveyed eight major refereed journals over a three-year time period. Most of the articles in the journal publications addressed technology applications, development, or implementation. Only about 18% of all technology research completed addressed an evaluation of learning outcomes. However, statistics indicate the almost *non-existence* of articles relating to the affective domain.

making through technology. Many of these questions fall outside of the realm of the cognitive domain. However, answering these questions will not only provide resources to satisfy cognitive concerns, but it will also provide a more complete representation of experiences in technology integration.

We need to work on broadening this relatively new field. We do not have the accounts we need of the emotional and social development of students to new educational technologies. The task of technology-focused, educational psychologists and teachers, then, is not only to establish more structured research and teaching agendas, but also to expand the diversity within those inquiries. I will also argue in this dissertation that *obtaining a deeper psychology of technology will afford a more multi-layered and complete understanding of pedagogy and technology implementation.*

A Deeper Psychology of Technology

A driving question for this research revolves around an exact definition of deeper (or "depth") in trying to obtain a deeper psychology of technology. Webster (Webster, 2000) defines deep as:

> 1: extending far from some surface or area; a: extending far downward; b: extending inward from an outer surface
> 2: characterized by profundity of feeling or quality

A deeper psychology of technology might therefore imply a profound examination of the uses of technology as defined by psychological terms. The problem with a simple definition like this is the relationship of deep psychology to psychoanalytic thinking. Somewhere in the term "deep psychology" is the idea

that if we dug far enough into the psyche of the individual using technology, we would discover beliefs and motives that justified the behaviors of the subject.

Coming to know a person who is using the technology, rather than focusing solely on the use of the technology itself, may be labeled under the banner of "people-centered analyses of technology use." The goal would be to examine the person who is using the technology and the ensuing relationship with the technology, rather than assuming that the characteristics and uses of the technology are somehow inherent in the technology itself. Nass and Reeves' work (Reeves & Nass, 1996), which concentrates on what they term the 'media equation', offers evidence that humans enter into social contracts and relationships with technology. They argue that interactions with new media like television and computers are fundamentally social in nature. Much like interactions in real life, people expect media to obey a wide range of social and natural rules.

Thus, coming to a more complete understanding of the individual and the human intentions they confer upon the technology is an important step in understanding effects of technology use. However, a deeper psychology of technology goes beyond merely addressing the human and his/her relationship with a technology. It is more concerned with expanding the vocabulary available to technologists and researchers as they explore educational investigations with technologies such as computers. This deeper approach implies not a psychoanalytic view of the individual, but rather a complete, comprehensive, and inclusive description of the instance of technology use.

This research might entail examining the constructions a person is able to make through and with the technology about the learning objective. Conversely, it might also address what knowledge an individual constructs about the technology itself, and the resulting differences and similarities with the constructions made by the teacher or the developer. More broadly speaking, research might also focus on the interactions that surround or are enhanced and scaffolded through the use of the technology. This would include the discourse between participants using a technology, the dialogue sustained through the technology, or an examination of the activity as a whole to determine what learning opportunities were supported and neglected while interacting with the technology.

This is not to argue that previous research has not attempted to meet any or all of these objectives. Rather, it is to suggest that many of these studies have stopped short of providing a comprehensive description of the events surrounding the technology use. Many instances of research have ended when achievements were assessed through behavioral measures such as test scores. Again, this type of research is not a wasted effort. Our growing field is in need of research that highlights cognitive gains made through educational technology. These types of studies have helped shed light on the technology effectiveness debate mentioned earlier. The fear, however, is that an incomplete (or less than comprehensive) description of the events lends itself to incomplete generalizations about future technology use. More complete descriptions and analyses of instances of computer use will foster better opportunities to label

interactions with technology in general. Educational Psychology, the discipline in which most educational technology programs are situated, offers itself as a prime source of extending and expanding a complete vocabulary for our new field. Psychology can provide the vocabulary that as descriptive and prescriptive tools to educational researchers and technologists.

In sum, those who study educational technology are determined to understand broadly why certain technologies are effective, and specifically why individuals interact the way they do with various technologies. This dissertation addresses the same objectives while attempting deeper and more complete analyses of innovation implementation.

Sarah's Story[6,7]

The struggle to understand technology innovations in education became vital for me in the summer of 1997. I was working with a team of graduate students and faculty at Michigan State University in a project aimed at implementing technology into special education and inclusion classrooms at a local elementary school. As part of the "TELE-Web" (Technology Enhanced Learning Environment-Web[8]) project, the team decided to purchase an eMate for each of the three classrooms in the study. (An eMate is an Apple product, a grandchild of the popular Newton series.) There were two main reasons for the purchase. First, special education children sometimes have a hard time typing

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[6] Sarah's story was first told at the Society of Information technology and Teacher Education (SITE) Annual Conference in San Antonio, Texas (1999), where it won "Best Research Paper" (Ferdig & Weiland, 1999).

[7] An experience much like mine with Sarah, Jeanne Bamberger tells a very fascinating story about 'Leon'—a quiet student who had extraordinary insights when giving the *pace* and *conceptual space* he needed to make new knowledge (see (Bamberger, 1999).

[8] TELE-Web is funded by the U.S. Department of Education and Michigan State University's College of Education. http://tele.educ.msu.edu/

on the computer. The researchers and teachers felt that if students had an opportunity to write on the screen, a technology the eMate provides, they may be more motivated to practice spelling, write stories, and read works to their colleagues and teacher. Second, the eMate is fun to use. The research team thought it would be interesting to see how the children reacted to new and exciting technologies in the classroom.

Shortly after the eMates were introduced, I began to work with one of the fourth grade students named Sarah.[9] Sarah, labeled by the school psychologist as "Educable Mentally Impaired (EMI)", had bonded with the eMate. She used it whenever she was required to complete a spelling test on a computer (she also had the choice of one of the "bigger" computers). She also used it to write stories whenever she had free time. From a cognitive perspective, Sarah made tremendous improvements over the course of the year. Her standardized reading test scores (SORT & Durrell[10]) as well as her general classroom grades improved. However, there was more to Sarah's story than mere test score improvements.

Sarah and her computer "Brian" became friends. The bonding could best be described as an intense, human-like experience. Not only did she talk to the computer (and assure the team members that it talked back), but she also named him and took care of daily needs such as its feeding. On occasion, she was even seen taking it to the bathroom.

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[9] Pseudonyms have been used for all school and participant names in this dissertation to protect identities.
[10] The Durrell Analysis of Reading Difficulty and the Slosson Oral Reading Test (SORT) are two standardized literacy tests given to measure reading level and word recognition (respectively).

At first, the teacher and the team member considered the situation nothing more than a curious phenomenon. However, Sarah's relationship with the eMate became more striking when she began using it to mediate relationships both in and out of school. In the classroom, she was one of the only girls in the resource room. She did not get along with many of the boys and complained often about the lack of girls in the class. She even wrote the following "complaint" and addressed it to Brian (translated for meaning):

> I sometimes want a girl but I can't get a girl. Mrs. K. will not let me get one. All my life I prayed for a girl but you are the only one I can talk to.

However, she decided to have her computer "be a boy." "Sarah needs to control things" her teacher commented. "This may be her way of controlling the situation with the boys in the class." When asked about how she knew the eMate was male, she responded with "cause I work on boys all of the time. I'm surrounded by them."

Sarah also mediated her relationship with her teacher via the eMate. Mrs. K would often help students evaluate their stories. The eMate took over this role and would tell Sarah which of her stories were good, which ones needed revisions, and which ones should be deleted. Mrs. K explained that for Sarah, the eMate represented manageable production. She would often say, "Look what I've done, Mrs. K." Mrs. K commented, "She is proud of what she has done with the eMate."

School was not the only environment in which Sarah mediated with the eMate. At a party during the school year, her aunt was murdered. She told us

that she could not tell Brian about the death because "it would cry." She spent much of the next few weeks after the death without Brian. It took her quite a while to learn how to tell "it" what had happened.

Assessing Sarah's Story

How does one learn to make sense of Sarah's story? Sarah was a poor student going through difficult times. However, she was not only able to maintain her composure, she was able to improve herself as a student and as a person (her teachers and her mother noted her improved behavior; Sarah, herself, commented on her increased happiness and satisfaction with school and 'life'). Did (and if so how) the relationship between the eMate and Sarah facilitate this growth?

It would be very easy to believe in the power of technology as you hear about a very emotionally troubled, at-risk student grow into a classroom representative, school leader, and better-than-average student through an interaction with a computer. It would be very easy to sympathize with the numerous teachers who heard the story and wanted an eMate for every student in their classes. It would even be fair to join with other researchers in the call for more exploration of eMate use in the classroom. However, as educators interested in technology research, the most important lesson to learn from Sarah's case is how important it is for us is to be able to explain (as best as possible) instances of computer use such as Sarah's story, to understand how and why this technology played such a powerful role in her life.

Notice first the pedagogy and instructional design afforded by the design of the technology. The size and battery power of the eMate allowed the computer to be in front of Sarah longer than the time spent in front of the larger, desktop computers or the one, heavy school laptop. The weight, size, and shape allowed her to hold, control, even hug a very interactive tool. She was able to take it under the table (her secret writing room), drag it with her to the playground (literally), and feed it during her lunch hour. The advantages of the design, in turn, provided more writing time during the school day, regardless of where Sarah was in the classroom (or out of the classroom). The teacher's main objective of increased writing time was certainly provided by Sarah's use of the eMate.

Just as important as the pedagogy was the personnel involved in the instruction. It is true that without the eMate, the instructor may not have been able to provide as much writing time for Sarah (although, as I am sure Richard Clark[11] would argue, we could probably find other media to accomplish the same important goal). However, without a competent instructor who knew how to use the eMate (both technologically and pedagogically), the tool may not have been used, or may have not been used to help students like Sarah. The classroom teacher knew enough technologically about the eMate to be able to get Sarah started (how to turn it on, how to create a new file, etc.). Moreover, she knew

[11] In a very famous article, Richard Clark makes the argument that technology influences learning as much a truck delivering groceries influences our nutrition (Clark, 1983); also see (Clark, 1994). The argument extends to the claim that media can replace each other. In this case, the eMate afforded something, but the argument would claim that other media could potentially do the same. Learn more about the 'Great Media Debate' between Richard Clark and Robert Kozma online at:
http://hagar.up.ac.za/rbo/construct/media.html

enough about what it could do to successfully create instruction for Sarah and her 'friend'. Finally, she knew enough about Sarah to know what instruction with the eMate Sarah could handle by herself.

Through the use of a technology, a strong writing curriculum, and a knowledgeable adult, Sarah completed group and individually assigned projects. She also spent a lot of her own time (recess, lunch, etc.) working on the computer. At the end of the project, the main goal of helping her develop literacy skills was realized. Sarah had learned to type, write stories, and spell better. Her classroom grades, especially those related to literacy, improved. Furthermore, her test scores on the SORT and Durrell standardized tests increased significantly ($p<.05$).

Re-assessing Sarah's Story

The initial research questions focused on cognitive growth as evidenced by that development of literacy skills (measured by standardized test scores). The accompanying research findings suggested that the eMate might make a promising tool for developing and improving literacy skills. Those questions and findings, however, had nothing to offer the research or the researchers when presented with a young girl initiating a human-like bond with a computer.

Initially, some of the team members wondered whether Sarah's interaction with the eMate was similar to a child having an imaginary friend or a doll. The eMate was a safe tool for Sarah. All of the students knew the importance that the teacher and visitors from the university had placed on technology. Her classmates, peers, and instructors would grant her more agency if she bonded

with the eMate than they would have if she had bonded with another toy, personal belonging (blanket) or instructional artifact. But, how did this differ from the actual psychological use of a blanket, doll, or imaginary friend? Trying to further understand these happenings, we turned to the psychological explanations of the influential British developmentalist D.W. Winnicott (1896-1971).

In his widely cited "Playing & Reality", Winnicott (Winnicott, 1971) suggests that infants, children, and even adults make use of "transitional objects." Transitional objects are objects or phenomena that are related both to external and internal reality.

> This intermediate area of experience, unchallenged in respect of its belonging to inner or external (shared) reality, constitutes the greater part of the infant's experience, and throughout life is retained in the intense experience that belongs to the arts and to religion and to imaginative living, and to creative scientific work. (Winnicott, 1971, p.242).

We hypothesized that Sarah was using the eMate as a transitional object between her internal reality and the reality that existed in the classroom and at home. In other words, it is probable that she was using the eMate much like a blanket, doll, or imaginary friend. Viewing the eMate as merely a computer used for spelling tests, even if it was important in her obtaining higher reading scores, one would have missed this "thicker description" of what was really happening and thus a more probing psychological account.[12]

[12] This application from Winnicott is but a small sign of the potential uses of psychological ideas in the study of Sarah and of educational technology in general. Other interpretations might have been suggested from areas such as Cultural Psychology (Cole, 1996) or Narrative Psychology (Bruner, 1996).

A More Complete Analysis of Sarah and her eMate

Sarah's story of technology use is inspiring. However, it would be faulty to conclude that teachers should use eMates in the classroom just because one student showed improved literacy test scores after using it. As a matter of fact, I believe it would be errant to make the claim even if one hundred students showed improved marks, without first coming to a more complete analysis of the situation. Realizing that comprehensive analysis, at least in this case, meant understanding both the psychology and pedagogy behind the tool use as well as the individual(s) who acted as the more knowledgeable or more capable others for Sarah (in Sarah's case, her teacher, and on occasion her parents, her friends, and even the eMate).

Sarah was not the only learner in this story. The teacher and Sarah's parents were able to better plan future educational activities for Sarah at school and at home. The teacher educators in the project learned more about what kind of knowledge a teacher needed to effectively use a technology. And the project researchers could design future research agendas around aforementioned evidence (i.e., the eMate was used as part of the writing curriculum). In sum, through an understanding of the pedagogy and personnel behind the tool, both the teacher and the research team were better able to understand, (more importantly) explain, and potentially replicate the cognitive gains Sarah had made.

However, stopping at the point of reinforcing or better understanding cognitive gains may have meant missing a more complete picture of the study.

Coming to terms with how Sarah was using the eMate also involved developing a deep understanding of the psychology behind the relationship she initiated. Attaining that depth helped the teachers and researchers better comprehend her emotional development and how to foster her emotional, intellectual, and social growth in the classroom. As the teacher said, "I now better understand how to reach Sarah." Drawing on the experiences in the social life of the classroom, the teacher was better able to help the parent understand the ways in which Sarah's behavior was changing at home. Sarah's mom, at a parent-teacher conference, told the teacher that Sarah was more willing to share thoughts and feelings and participated more in family activities. Finally, it opened up new possibilities for the use of the technology with other social and emotionally disturbed children.

A deep psychological exploration helped teachers and researchers realize that the development of questions and the analyses of the innovation did not start and end with cognitive gains (or the lack thereof). Rather, it grounded the experience of the innovation in the personnel, pedagogy, and psychology that made up the innovation.

Understanding What Makes a 'Good Innovation'

In describing a technology used to improve writing skills, Krendl et al. (Krendl, 1996) claim that a rich technology experience is not defined by any one feature, but by a combination of elements (the child, the adult, the technology, the setting, etc.). Therefore, as echoed by this dissertation, the research mandate for educational technology, and one way to achieve a deeper

psychology of technology, is to explore the ways in which these different elements interact to create a 'good innovation.'[13]

What exactly do we mean by a 'good' innovation? Was the eMate in Sarah's case an example of a good innovation? Many would define 'good innovation' as one that improves performance, successfully meets a pre-defined plan or solves an educational problem (in this case, through the use of technology such as computers). For instance, a good innovation would use technology to help students become better readers. Or, a good innovation would increase SAT scores after continued computer use. I argue in this dissertation that *there are at least three necessary elements that characterize a good technology innovation.* Those three elements both define and answer the question of what makes a good innovation.

A good technology innovation requires the "Three P's":

1) Good Pedagogy
2) Good People
3) Good Performance

The first two, the good pedagogy and the good people, help define the term 'good innovation'. A good innovation is one where *technology and pedagogy are not separated.* A good innovation engages *a process that enhances the relationships among innovator, educator, and learner.* Unfortunately, in much of the available research, pedagogy and personnel take a backseat to an interest in cognitive gains. Thus, asking whether an innovation

[13] The mandate for research to understand, explain, and describe what makes a good computer innovation has been reiterated numerous times in the literature. The first example that comes to mind is Sharon Derry & Susanne Lajoie, who state that the impetus for editing *Computers as Cognitive Tools* was to understand what good pedagogy is and how computers systems will enhance that instruction to create good pedagogical tools (Derry & Lajoie, 1993). A second instance is Thomas Reeves' invited address at the 1999 Educational Media Conference (Reeves, 1999). Reeves argues that we need to focus our energies on the invention, understanding, and improvement of creative learning technologies.

improves SAT scores or improves reading skills *may* obscure important factors that will later prove important in helping understand, explain, or replicate the research findings.

The third factor, Good Performance, helps answer this question: if a good innovation is one in which the pedagogy and the technology are closely linked, how can one tell if the performance (that is, the outcomes and the implementation) of the innovation was good, successful, etc.? At this level, we can draw from *psychology to afford a more multi-layered and complete understanding of the performance of the technology and its implementation into pedagogy*. This third level may indeed use cognitive psychology to assess changes in SAT scores or improved reading levels. However, it may also explore the innovation as something that helps a child make a transition, mediate with others, or learn more about herself. The claim is that good is not defined solely on cognitive measures.

Given this definition, the use of the eMate with Sarah was a good technology innovation on two levels. First, the innovation was pedagogically sound; it was well designed, rooted in a strong writing curriculum, and supervised by a more knowledgeable other. Second, the eMate produced good results both cognitively and affectively. In this sense, good refers to the success or failure of the goals of the technology innovation. Cognitive gains, the intended consequences of the use of the technology, were measured by standardized literacy tests. Affective gains, the unintended consequences of the technology use, were rendered plausible by using a framework (D.W. Winnicott's theory of

transitional objects) to explain how and why it facilitated Sarah's learning and development.

The main goal of a deep, psychological examination of an innovation is to ensure a deep and complete enough analysis so that: a) cognitive changes, whether they exist or not, can be explained in relation to the person using the technology in a curriculum, rather than explaining it as an intrinsic quality of the technology itself; b) stronger and more definitive claims can be made about the instance of implementation; c) teacher educators are provided with more comprehensive information about what and how to train future teachers or in-service teachers learning technology; and d) unintended consequences, mostly appearing as affective, social, and emotional changes, can be measured.

Choosing a Case Study to Examine 'Good Innovation' Implementation

In order to learn more about what made a good innovation, I began a research project in a Midwestern elementary school. Rose Park is a K-5 elementary school located in a large, urban school district. The demographics of the third grade class in which I worked were very representative of the school itself. 99% of the students were eligible for free or reduced lunch, a majority of the students came from single parent homes, and the class was comprised mainly of minority students (66% African-American, 21% White, 12% Latino, 1% Foreign).

I chose to work with Danielle, a Caucasian female, because I knew that I would find an instance of successful technology integration in her classroom. I had worked with Danielle, the third grader teacher at Rose Park at the time of

this writing, for over three years on other technology projects, so I knew of both her expertise and interest in educational technologies. Danielle had taught for over twenty years, but only recently had joined the Rose Part teaching staff. In the short time she had been there, she was promoted to technology coordinator for the school and acted as a technology representative at district meetings and statewide technology conferences. With local, regional, and even statewide recognition for her technology expertise, I believed that exploring technology integration with Danielle would provide a chance to answer the question of "What makes a good technology innovation?" Furthermore, it would afford the opportunity to examine the benefit of a deeper and more complete analysis of that implementation.

A research project in Danielle's class also seemed inviting because she had mentored student teachers for two years. I had been privy to her implementing technology in the students' curriculum. However, I had not yet seen how she talked about her work to her peers, nor had I seen how she would teach her understanding of technology integration to others. Her intern was Elizabeth, a self-proclaimed, "older African-American student who knew nothing about technology," but she was very excited to learn about technology and education in her final internship year prior to teaching in her own classroom.

Prior to a more detailed exploration of what made a good innovation, I needed to choose a methodology that would provide access to a more complete analysis. Understanding the pedagogy behind any given technology integration, as well the personnel to implement that innovation seemed straightforward

enough. Observations, interviews, and explorations of lesson plans would provide a more complete description of the necessary curriculum and personnel skills associated with the innovation. Furthermore, getting at some of the psychology behind the implementation, specifically the cognitive components, appeared as simple as a pre-test and a post-test. However, getting at unintended consequences of technology use, especially those affective, social, and emotional effects, was a more daunting task (Kirkwood, 1998). Two potential solutions, those used in this dissertation, are described below.

Getting to know a person

Dan McAdams argues that one way to attain analytic depth in studying a phenomenon is to get to know the person or persons involved in it (McAdams, 1995). Getting to know a person would provide insight into the changes they experienced as a result of the technology implementation. This is an important step as not all technology interactions have outcomes as transparent as Sarah hugging an eMate. Although McAdams confesses that one never 'truly' knows another in full, perhaps not even oneself, he believes that people can be described on three loosely related levels of functioning. The first level consists of a person's traits, and can specifically be situated around 5 main traits: extraversion, neuroticism, openness to experience, conscientiousness, and agreeableness. Getting to know a person at this level is equivalent to getting to know a stranger.

The second level digs deeper into the personhood by trying to understand personal concerns. These personal concerns include "personal strivings, life

tasks, defense mechanisms, coping strategies, domain-specific skills and values, and a wide assortment of other motivational, developmental, or strategic constructs that are contextualized in time, place, and role" (p. 365). McAdams lists these personal concerns as he argues that to know a person more fully than one would know a stranger, one would have to know information that is "exquisitely conditional and contextualized" (p. 376).

Finally, level three represents understanding the life story and intentionality of the individual. McAdams argues that without exploring this level, "(one) can never understand how and to what extent the person is able to find unity, purpose, and meaning in life" (p. 382). He argues that western adolescence requires the creation of a life-story, which in turns help define identity. Our interest in knowing a person much better than we know him/her now entails listening to their life story.

Understandably, McAdams developmental framework is aimed at personologists who are interested in a comprehensive view of the identity and personality of the individual. This is not to argue that a technologist will lack success in research unless the complete life-story of the individual is known. Rather, it is to suggest that McAdams' levels of understanding might provide a fresh insight into ways of coming to a more comprehensive view of the individual and the changes they experience as a result of the interaction. Technology research, as Reeves & Nass (Reeves & Nass, 1996) have suggested, would be improved by viewing the individual as one of two sides in a social contract—a side that has a personality of its own. Simple descriptions of the characteristics

and traits of the individuals would afford a different angle on interactions during use of the technology. Personality tests or inquiries into motivations of the individual might help researchers understand why certain technologies work and others do not. Finally, individual cases, such as those presented in this dissertation, would provide a deeper investigation of the technology exploration by soliciting the life-story of the subject.

Understanding the social context

One tool to help educational technologists in their research is a multi-level scheme of the individual as presented in work by McAdams. McAdams framework helps us better understand a person; however, technology integration and use by the individual does not occur in a vacuum. Many times the individual is working with one or more partners, and is almost never without the direction, instruction, or scaffolding of the teacher, researcher, or developer, whether that instruction be implicit or explicit.

A second necessary component to this methodology, then, is one that allows us to more deeply understand the individual in the context of the culture or society in which he or she resides. Geertz addresses this issue in his book Local Knowledge (Geertz, 1983). He highlights the fact that trying to know a person goes beyond seeing the individual as a bounded and well-defined whole. It also includes understanding the semiotic means by which persons are defined by one another.

He argues that in the land of the blind, the one-eyed is not king but spectator. In other words, to understand anything from the subject's point of

view, a researcher must try to figure out "what the devil they think they are up to" (Geertz, 1983). The trick, Geertz argues, is not to try to put oneself into another's skin. Rather, it involves trying to determine how the subjects define themselves. Geertz writes:

> I have tried to get at this...not by imagining myself someone else, a rice peasant or a tribal sheikh, and then seeing what I thought, but by searching out and analyzing the symbolic forms—words, images, institutions, behaviors—in terms of which, in each place, people actually represented themselves to themselves and to one another. (Geertz, 1983)

Thus, where McAdams starts a framework to know a person as an individual, Geertz completes the approach by acknowledging the subject as a social actor. Where McAdams encourages us to hear the life stories of the individuals, Geertz asks us to observe what is being told, to whom, in what forms and images, and with what consequences. In order to fully understand a technology integration experience, one begins to see the importance of not only understanding a person deeply, but also the context in which a person resides. Interpreting this context as best as we can becomes defined as Geertz's "Thick Description." The goal of thick description is "setting down the meaning particular social actions have for the actors whose actions they are" (Geertz, 1973a). It is achieved by inscribing social discourse and includes "interviewing informants, observing rituals, eliciting kin terms, tracing property lines, censusing households...writing (a) journal" (Geertz, 1973a).

McAdams focuses on the individual and views speech as thought. Gaining access the stories of an individual provides insights into the thoughts and thought processes of the subject. Conversely, Geertz views speech as

action. One can achieve depth of understanding of an individual by observing them in the context of the semiotic relationships with others. The aim of this dissertation, then, is to join both methods in pursuit of a more complete and deeper understanding of technology innovations. With both the tools to describe semiotic representations thickly and to know a person, we begin to be able to "uncover the conceptual structures that inform our subjects' acts...and to construct a system of analysis in whose terms what is generic to those structures...will stand out against other determinates of human behavior" (Geertz, 1973a).

"Got Milk?"

Armed with observational techniques from Geertz and an interview protocol adapted from McAdams (Appendix A), I was prepared to enter Danielle's third grade classroom. I wanted to observe Danielle, Elizabeth, and their students as they worked with a writing project Danielle had created. In the project, computers would be used to gather data and write research reports. I went to the classroom the first day of the research project, laptop, video camera, and tape recorder in tow, ready to explore writing with the students.

As I entered the classroom, some of the students ran up and said, "Mr. Ferdig, Mr. Ferdig! Will you help us make a video?" It took about ten minutes to actually make my way into the classroom that day, having to work my way through small waves of excited children. When I finally met up with Danielle and Elizabeth, they explained the situation.

In the few days prior to my visit, the students drew the lucky piece of paper out of the 'Good Behavior Rewards Jar' and won the opportunity to eat lunch in the classroom with Danielle and Elizabeth. [14] After lunch, the students noticed many full and half-full containers of milk dumped in the wastebasket. They began to ask themselves, "Do we have a problem here?" In the conversation that ensued, Elizabeth recalled: "the students felt convicted thinking about their waste and the people in the world who did not have food or milk." With the teachers' help, all of the students 'brainstormed' and put a list of things

[14] "Won the opportunity" sounds like I am being sarcastic. When I was in school, having to eat lunch with your teacher meant you did something wrong. Now it is actually a very positive thing; the teacher brings in an extra treat for you, and the students tell me that the teacher lets them get away with more than the legendary 'Lunch Lady' does.

on the board that they could do to help others learn about this problem. They wanted people from around the world to know that "wasting milk was bad because milk was good for healthy bodies." Examples of ideas the students had for the project included: writing poetry, writing argumentative essays, building a PowerPoint presentation, visiting other classrooms, and making a movie. The class voted, and decided that a movie would be the best way to share their concerns with others. After talking it over with the teachers, they felt like another medium of presentation might be as convincing, but a taped movie would allow them to share their ideas with many others even after they had graduated to fourth grade and beyond.

I barely had enough time to listen to Danielle's story before I was once again mobbed by the students and cries of "Can we? Can we?" Persuaded by their conviction, I agreed to help. I suggested that the first task in creating a movie would be to understand what it took to produce a movie. The students, teachers, and I spent time talking about the different components that made up a movie. We decided that a good movie campaign would consist of such things a trailer, an introduction, supporting evidence, and a jingle. Based on these divisions, students signed up for the task they wanted to work on.

Danielle and Elizabeth initially conceived of this project as a two or three day event, mainly connected with the development of literacy skills. Students would get together in their chosen groups to write a script describing what their part of the movie would look like. After they had agreed on a script, they would perform, review, edit, and re-perform their videotaped screenplay. Through this

process, students would practice skills such as writing, reading, and public speaking. However, while listening to the different groups plan their presentation, the teachers quickly realized the larger potential impact of this project. Students were developing screenplays that involved the learning, use, or refinement of skills from other subject areas such as math and science. One group of students wanted to know more about the natural process of milk production. Another group wanted to poll neighbors and friends to see if they wasted milk. A third troupe concluded a visit to the lunch area would be the only sure way to gather evidence. Consequently, the main task for Danielle, Elizabeth, and I was to understand how to bring the group learning to the whole class.

After the students had completed the different parts of the movie, a student-designed CD-ROM was produced ('burned') that contained all of the artifacts created during the production of the video. These included: the movie itself, scanned images of early scripts, scanned images of graphs and charts created through the process of collecting evidence, posters for the "Got Milk?" campaign including student voiceovers describing their posters, and transcripts of chatrooms that students used to discuss what they wanted the movie to look like. Creating the CD-ROM served three main purposes.

First, it was an archive of the project, almost like a yearbook, for the students (each student was given a CD-ROM), teachers, and researcher. A second goal was for the CD-ROM to serve as a learning tool for other teachers. Thus, the CD-ROM also contains videos of: a) its presentation to other

classrooms; b) teachers describing the creation and development process; c) its relationship to state technology and curriculum standards; d) the role of learning theory in some of the components; and e) its development from a technological perspective (what it took to make it). Third, students wanted to share what they had learned with others from around the world. Although a version of the project was to be added to the school website at a later date, the CD-ROM format allowed easy and relatively cheap distribution of the video and related components ($1 per CD).

The CD-ROM proved extremely useful in the last few weeks of the project. Equipped with the CD-ROM, the teacher's laptop, and a projection device, the class was able to share the movie and other artifacts of the learning process. "Got Milk?" presentations started with a short introduction and the viewing of the video. Students would then use their posters to explain what they had learned about the benefits of drinking milk and why others shouldn't waste food or milk. Presentations ended with a toast to milk, including a cold glass of chocolate or white milk and, of course, cookies!

Based on its initial success (as indicated from compliments the class received from its early program graduates), we decided to send the "Got Milk?" CD-ROM to a multimedia competition for elementary students. We had hoped the technology competition would give us a chance to share the program with other districts and schools around the state, regardless of the contest outcome. Unfortunately, after much deliberation, the awards committee decided to disqualify our entry. They reported that it was unlikely that students could do the

caliber of work that was on the CD-ROM. They assumed that adults created and completed the entire project with little student involvement. We explained to the judges that the students had a major role in each and every production phase. It was at that point that the main judge confided that they were unsure what to do with the CD-ROM because they never had received anything like it. They informed us that they were more used to simple PowerPoint presentations and straightforward Hyperstudio stacks. The judge was unsure whether movies, web sites, video, and audio even counted as multimedia.

As one could imagine, we were all disappointed with the decision. The teachers commented that the students were especially upset—not about losing, but about not even being able to partake in the competition. They saw the contest as a chance to share their work with people outside of their immediate community, and to have that work denied entry crushed the students' sense of accomplishment.

A day or two after the judge's phone call, we had a visit from the district technology coordinator. She had heard about our creation and our presentation to other classes. She invited us, on behalf of the Governor, to represent the school at the statewide Governor's Technology Conference. Danielle, Elizabeth and seven of the third grade students attended the conference, and while handing out free glasses of milk, talked about the importance of health and eliminating waste. For their hard work, the students were awarded second place in the showcase competition, a prize awarded over all other elementary schools,

middle schools, high schools, and technology academies invited to the conference.

All of the students were greeted with honors after the conference and were invited to present at both the PTA meeting and the local city council meeting. Two newspapers covered the council meeting, where the mayor applauded the efforts of the school and the children in bridging technology and education. One reporter hailed the presentation as "one of the most innovative projects in the state—in all age groups" (Golembiewski, 2000). Another reporter, showcasing the event on the local television news, suggested that the students send their project to the Rosie O'Donnell show to receive national attention.

The teachers were very pleased with the project, especially looking back at the pedagogy and academic content in relation to state standards. Specifically, the state's Department of Educational Technology Plan called for students to participate in a project-oriented approach to technology, with the outcome consisting of introductory multimedia projects. The "Got Milk?" movie and CD-ROM certain qualifies for more than 'introductory' status; yet, it also fulfills and exceeds the Department's goal of students applying appropriate technologies to critical thinking, creative expression, decision-making, problem solving, and communication. Most importantly, the teachers were able to facilitate this achievement while preserving the focus on state curriculum standards in math, science, social studies, language arts, etc.

Was this technology innovation a success? Was the 'Got Milk?' video a good innovation? Based on the attention, awards, and recognition received at the local, regional, and statewide levels, the innovation was a 'good' one. However, as I will argue in this dissertation, the project was successful (cognitively and affectively) because it exhibited sound pedagogy, it impacted the personnel in the project in positive ways, and it resulted in positive performances —its implementation and impact—as measured by a deeper psychology of technology. A deep and more complete analysis reveals findings that substantiate why students learned, how teachers taught, and some important unintended consequences of the implementation and research surrounding the implementation. These factors, in turn, not only guide future research, they also present important understandings for the field of educational technology. In the chapters that follow, I intend to unpack and carefully examine each of these claims.

Chapter 1: The Pedagogy behind "Got Milk?"

Introduction

> Using CD-ROMs for open and distance education does not necessarily equate with improving teaching effectiveness; it all depends upon the pedagogical design and purpose of particular discs. If a CD-ROM is viewed primarily as a storage device or delivery mechanism, the resulting structure might be similar to an encyclopedia—a great deal of content, but devoid of any specific teaching or learning goals.
> (Kirkwood, 1998)
>
> As important as it is for instruction to accommodate new technologies, it is just as important for the design of these technologies to accommodate the instructional needs of teachers for literacy and learning.
> (Leu et al., 1998) p. 203)

After three years of working with Danielle, I knew that she would try anything in her classroom related to technology because she believed two things: a) any experience with new technologies would broaden her students' horizons (because); b) she could integrate almost any technology into a learning tool for her students. Danielle does not believe these things because she thinks she is a technology expert. She describes herself as "just a teacher who is interested in the teaching and learning potential (pedagogical value) of new technologies." However, years of experience taught her that most technologies are flexible enough to be adapted to the curriculum and will prove fruitful to students, even if just as an introduction to the tools that would eventually greet them as "students of the information age."

Because of her beliefs, her technology accolades, and my past experiences with her, I was fairly confident that her classroom would provide an arena to explore technology integration. However, when we first spoke, I had intended to study a writing project she was about to implement. Danielle believed in the students' active construction of their own identity and wanted to do a yearlong project called 'Constructing Me.' She believed that the computers would play a key role in helping students reflect on their lives, as well sharing their life stories with others. A week or two before the project began, the students and teachers decided they had a more important project to do. [15] This new project, the "Got Milk?" program ended up being successful (on one level) because it was imbued with 'good pedagogy.'

What do we really know about technology and education? We know that *a good technology innovation is one that is integrated with academic content and good pedagogical practice.* [16] Technology research provides evidence that even

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[15] It is difficult to place a value on something of 'more important', especially when you are comparing that thing to helping students understand something as important as learning that they construct their own future. As will be documented in this dissertation, however, the 'Got Milk?' project helped students learn they have control over who they become and what they do in life *by* helping and teaching others. Thus, as following the pedagogy set forth in this section, they were actively creating a sense of themselves as owners of their own development by collaborating in authentic problem solving activities, participating in social learning relationships, and publishing artifacts. Granted, this may have been achieved through the original writing project; however, in this project, students accomplished these goals by solving an authentic problem of how to help *others* learn about (and consequently how to solve) a problem.

[16] Along with other researchers (Norman, 1993; Salomon, 1993), I started this discussion by making the claim that no technology innovation is inherently good or bad in and of itself. This, in turn, begs the question, "what makes a good innovation?" Gavriel Salomon (Salomon, 1993) pursued this line of argument, and came to two important conclusions. First, it is difficult to judge the 'goodness' of a technology outside of the purpose for which it was created. In other words, a screwdriver is a good innovation in some cases, and potentially bad at times when a wrench is needed. The second conclusion is that in the light of number one, the value of innovations should be judged on their pedagogic value (i.e., tied to pedagogic goals, pedagogic assessments, etc.). I agree with Salomon, and thus devote this chapter to an understanding what makes a good pedagogical tool. The next two chapters are allocated for pushing beyond just pedagogy to describe other important features of a 'good innovation', namely personnel and psychology. The aim of the combination of the three is to describe a more complete approach to understanding technology innovations.

without the interaction of more knowledgeable others, prior pedagogical goals, or a strong teaching program, children *may* construct their own curriculum and their own purpose for classroom technologies (Webb, 1996). However, technology use in the classroom is not necessarily an end in and of itself[17] (except, perhaps, in the case of an instructor teaching a computer course), nor should it be left up to chance as to whether the student uses it as a medium in learning. In most cases of chance, instructors and students leave the machines to gather dust (Kinzer & Risko, 1998; Miller & Olson, 1994; Webb, 1996). In other scenarios, technology plans without pedagogical considerations result in mindless technology 'checklists' devoid of any strong ties to curriculum (i.e., keyboarding, word processing, and desktop publishing skills learned by the end of the third grade) (Berrien, 1998).

What does it mean, then, to create an innovation steeped in academic content and practice? Mainly it entails tying it to learning theory to create authentic and engaging activities for students. From a social constructivist perspective[18], this means:

> -The innovation must be imbued with authentic, interesting, and challenging academic content (at the high end of the students' Zone of Proximal Development).
> -Participants must have a sense of ownership.
> -There must be opportunities for active participation, collaboration and social interaction.

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[17] See Kirkwood's (Kirkwood, 1998) discussion of educational concerns vs. technological concerns.

[18] We know very little of Lev Vygotsky's complete works due in part to the minimal amount of his writing that has been translated from Russian. However, the writing that has crossed the ocean has spurred an interest in what is known as socio-cultural thought and social constructivism. Like Piaget's individual constructivism, it highlights the knowledge construction process of the learner, with a major exception being the emphasis of the learner situated within a culture, society, or institution. "The basic goal of a sociocultural approach to mind is to create an account of human mental processes that recognizes the essential relationship between these processes and their cultural, historical, and institutional settings" (Wertsch, 1991). (See (Vygotsky, 1978).)

-The curriculum and technological tools must provide chances for the creation of artifacts in a variety of ways.
-Publication, reflection, and feedback play a key role throughout the project. [19]

Authentic, Interesting, and Challenging Content

The "Got Milk?" project was a good innovation because it was steeped in good pedagogy. Students *actively participated* in the design of both the problem and the solution. Although the teachers and students both noticed the wasted milk, the students decided that it was an *authentic problem* in their lives. Many of them had personally experienced the frustration of seeing wasted goods after being without food or drink. Others knew friends that didn't drink milk because they did not think it was 'cool.' The project would solve an authentic problem that they had discovered (and described) with a solution they had created.

Immediately upon hearing the terms 'authentic problem', most people think of mathematics story problems such as: "Bill and Nancy are in separate cars heading away from each other at 60mph..." Actually, authentic content refers to content that is meaningful, worthwhile, feasible, and anchored in a real-world problem (Newman, Secada, & Wehlage, 1995; Blumenfeld, Krajcik, Marx, & Soloway, 1994; Englert et al., 1998; Krajcik, 1994; Scardamalia & Bereiter, 1991).[20] Albanese states that this type of learning is an instructional methodology characterized by the use of problems as a context for students to learn problem-solving skills and acquire knowledge about the topic they are

[19]Many researchers would also include the use of cognitive tools such as computers as an important component of this learning perspective (Krajcik, 1994; Linn, 1991; Salomon, 1993). As this dissertation focuses on technology use in the classroom, the use of cognitive tools is an omnipresent (although not necessarily listed) assumption of this research.
[20] I suppose by that rationale, two cars heading in different directions might be meaningful to someone in some context dealing with a similar problem.

studying (Albanese & Mitchell, 1993). Kolodner (Kolodner, 1997) adds that students learn in these situations "by having rich experiences that motivate the need to learn and that give them a chance to apply what they are learning" (p.61).

It is important to have authentic, real-world problems because they are interesting and meaningful to the students and thus engaging. "Designers of successful classroom interventions must make sure that they are engaging enough to seduce children into the world of learning...Once ensnared, it may be possible to guide students toward the intrinsic rewards that follow from self-initiated disciplined inquiry" (Brown, 1992). Interesting problems, in turn, create significant missions for the students to fulfill; learning occurs in the context of carrying out that mission (Kolodner, 1997).

The students in Danielle and Elizabeth's class decided to tackle the problem of waste. Because it was their project, and thus authentic to them, they were interested in the learning that would be required to solve the problem. They did not see graphing as part of a mathematics lesson, but rather a tool to share what they had learned from visiting the lunchroom. They viewed the maps on the wall as places where dairy farms existed, not a geography lesson.

Content that is authentic and interesting engages the student. Sometimes, the technology is the component that makes the content more interesting. For instance, students could write a letter to their local Congressional Representative without the use of a computer. However, using a computer that speaks their words back to them, allows them to paste in pictures,

and translates their text as they write on the screen may motivate them and even peak their creativity. At other times, the technology affords the content to be authentic. Writing a letter to an animal expert to learn more about Penguins is an authentic task, but might be unrealistic due to the time constraints of finding an expert, writing the letters, mailing the letters, and waiting for a response. The teacher may decide instead to just have the students write the letters and never send them. Compare that experience to the experiences of Danielle and Elizabeth, who visited a dairy website, obtained the name and email of a milk expert, had the students email the class letters, and heard a response the next day.

Along with being authentic and interesting, content that is supported by technology must be challenging to the students. A main tenet of Vygotsky's theory is the importance of aiming instruction at the upper boundaries of a child's 'Zone of Proximal Development' or 'ZPD' (Brown & Ferrara, 1985). The ZPD is defined as:

> the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers. (Vygotsky, 1978, p.86)

In other words, if instruction is too easy for the student, they will lose interest; if it is too hard, they will become frustrated. The goal is to use content that is at the high end of their ZPD, where learning takes place with adult guidance or collaboration with more knowledgeable or more capable others. The child still acts as the agent in the learning activities, but knowledge emerges from the social interactions between the child and the adult or more knowledgeable

other (Scardamalia & Bereiter, 1991). These other participants scaffold the learning such that the individual constructs knowledge at a level unreachable by him or herself alone.

In the "Got Milk?" project, the students became the writers and producers of their own movie segments. Working with the teacher gave them the opportunity to explore not only what they already knew, but also what they needed to know. Their self-directed learning was guided in the meeting times with the teacher. However, it was also supplemented and reinforced as they became the more knowledgeable others—teaching their colleagues what they had learned upon returning to the class. Although Danielle, Elizabeth, and I all played important roles in scaffolding their development in the ZPD, technology was also integral. Students were able to use the Internet to ask questions to experts about milk and the dairy industry. They then used the computers in class to post notes to one another when they had questions, comments or thoughts. Again, in both processes, they not only were scaffolded in their development, but they also learned how to scaffold others' development.

There are many exciting possibilities for the role of technology and learning in the student's Zone of Proximal Development. Two existing examples besides the "Got Milk?" program include the CSILE and TELE-Web projects. CSILE, developed by Marlene Scardamalia and Carl Bereiter, stands for Computer Supported Intentional Learning Environments. The creators describe CSILE as "a networked system that gives students simultaneous access to a database that is composed of text and graphical notes that the students produce

themselves and a means of searching and commenting on one another's contributions" (Scardamalia & Bereiter, 1991, p. 38). CSILE was developed to support and sustain learning environments that focus on knowledge building. However, unlike traditional knowledge-based models directed by teachers, *students* use the technology (databases, note creation, etc.) to set cognitive goals, ask stimulating questions, monitor comprehension, and activate prior knowledge (Scardamalia & Bereiter, 1991; Scardamalia & Bereiter, 1994). In doing so, the technology provided students with a higher level of agency in their Zone of Proximal Development. This process, in turn, stimulates higher order thinking (self-regulatory behaviors) and guides students into more independent thinking (Salomon, 1993).[21]

TELE-Web, mentioned earlier in this dissertation, is the Technology-Enhanced Learning Environments-Web. It is a technological instantiation of the Early Literacy Project (ELP) developed by Carol Sue Englert and others at Michigan State University.[22] "Although the Early Literacy Project showed significant effects of the literacy curriculum on the reading and writing performance of students, there were several issues that warranted extensions of the work into literacy applications involving technology" (Zhao, Englert, Jones, Chen, & Ferdig, 2000a). In these extensions, researchers studied the potential

[21] Salomon gives the example of a physician to better explain how technology can help in self-regulating and higher-order thinking (Salomon, 1993). An 'expert' technology that helped a doctor diagnose illnesses would be performance-oriented in nature. However, a system that cultivated the doctor's own skills would be pedagogic in nature. Pedagogic tools are better for education as they "turn effects *with* them into more lasting effects *of* them" (p. 184). Students use pedagogic tools like CSILE to attain higher order thinking skills such as self-regulatory behaviors.

[22] ELP, "designed for use in primary-grade classrooms for students with learning disabilities, was intended to build literacy skills and impart learning-to-learn strategies" (Englert, Raphael, & Mariage, 1994). ELP strategies include: a) journal writing; b) story response; c) choral reading; d) thematic units; e) report writing; and f) book sharing.

of using technology to better scaffold student learning. The technology-based learning environment provided such things as text-to-speech and speech-recording functions, an increase of access to information, a larger authentic audience of teachers and peers, and prompts for students who were reading or writing. Research on TELE-Web has provided evidence that these tools, and the social interactions made available through them, served to scaffold mediated performance in the students' ZPD (Zhao et al., 2000a).

If the Zone of Proximal Development is defined by activities the participants can handle cooperatively better than they can alone (Scardamalia & Bereiter, 1991), then evidence suggests that technology can plan a role in making learning challenging by placing it at the high end of the student's ZPD. In one case, research supported the notion that technology tools provided space for authentic and interesting content, as well as opportunities for scaffolding mediated performance in the ZPD (Englert et al., 1998; Zhao et al., 2000a). In another case, the technology environment was used to help students take over the adult regulating role (Diaz, 1990; Scardamalia & Bereiter, 1991). In the "Got Milk?" project, a student-directed initiative allowed the teachers to work with authentic, challenging problems in the students' ZPD. The students were then enabled to act as more knowledgeable others to their colleagues. All three cases represent technology innovations as cognitive tools helping students "transcend their cognitive limitations and engage in cognitive operations they would not have been capable of otherwise" (Salomon, 1993).

A Sense of Ownership

The active construction of knowledge means that the student learns to take on a self-regulating role in the learning process. This active construction has become the forefront of many education mission statements, specifically stating: "the self-regulated learner must have a healthy self-concept with a strong understanding that they, alone, are in control of their learning, mastery of tasks, and attainment of goals" (Sandford & Richardson, 1997). The emphasis is on student control of their learning, where opportunities for that ownership are available in the design as well as the solution of the project or problem.

Technology can offer ways for students to establish that personal intellectual ownership of new concepts while they visualize and interact with abstract ideas (O'Shea, 1999). An example is the after-school computer clubhouses run throughout the country. Students in these clubhouses have the freedom to create and participate in their own projects. When given this ownership, control and responsibility over their learning, students developed creative problem solving skills, personal connections to knowledge, a sense of audience, and a private area for reflection (Resnick et al., 1999; Zhao, Mishra, & Girod, 2000c).

In the "Got Milk?" project, although students collectively agreed on producing a movie, other student choices were subsequently created artifacts used in the campaign. These included posters, drawings, web pages, interviews, stories and poems. All of the students therefore shared *a sense of ownership*, whether seeing it in the choices they had voted for, the secondary artifacts that

were created, or the *collaboration and group interaction* that surrounded the creation of the artifacts. Each student also participated in the technical production of the campaign, *using the tools experts would use to accomplish the same task*. They would take turns videotaping, audiotaping, directing, searching the web for information, taking digital pictures, scanning, editing, and adding voice-overs.

Active Participation, Collaboration, and Social Interaction

Closely tied to the idea of the Zone of Proximal Development is the notion that good innovations must provide opportunities for active participation, collaboration and social interaction. Active participation has seemingly become a catch phrase in any learning theory that opposes itself to "traditional didactic approaches to education, which seem to be based on an assumption of direct transfer of knowledge from teacher to student, without an intervening constructive process" (Scardamalia & Bereiter, 1991, p. 38). In other words, knowledge is not transmitted from the expert to a passive learner; rather, learning is an enculturation process where knowledge is actively constructed within the student's ZPD with the help of more capable others (Brown, Collins, & Duguid, 1989; Rogoff, 1994). This active participation takes place as students talk, write, relate, and apply among other things, and is present in both the design of the problem as well as the design of the solution (Chickering & Gamson, 1987; Kolodner, 1997). The design of Cognitively Flexible Hypertexts (CFH's) is one key example of how a technology innovation can scaffold active participation.

Cognitive Flexibility Theory (Spiro et al., 1988) is a constructivist response to the difficulties of advanced knowledge acquisition in ill-structured domains. "A central claim of CFT is that revisiting the same material, at different times, in rearranged contexts, for different purposes, and from different conceptual perspectives is essential for attaining the goals of advanced knowledge acquisition (mastery of complexity in understanding and preparation for transfer)" (Spiro, Feltovich, Jacobson, & Coulson, 1992). CFH's, hypertexts that draw on Cognitive Flexibility Theory, support a crisscrossed landscape of the knowledge area and thus convey ill-structured aspects of knowledge domains. Most importantly for this discussion, rather than pre-specifying knowledge, CFH's provide exploration environments in which students work with building blocks to assemble knowledge. Furthermore, a principle tenet of CFH's is that "the phenomena of ill-structured domains are best thought of as evincing multiple truths: single perspectives are not false, they are inadequate" (Spiro et al., 1992). Thus, participation is scaffolded such that students do not form singular truths but actively create multiple narratives and knowledge arrangements for different purposes.

Active participation is a necessary component of constructivist learning theories, and thus also a major tenet of those theories which espouse a social perspective on learning (Wertsch, 1991; Prawat, 1996). And, as evidenced by the research on CFH's, active learning can be supported and enhanced with technology use. However, active participation also includes learning in shared endeavors with others—a reason why social interaction and collaboration are

other important features of technology innovations (Linn, 1991; Rogoff, 1994). Thus far, I have highlighted collaboration and social interaction as being with an adult or a more capable other. In the example of TELE-Web, a teacher was able to create prompts, specified assignments, and other learning tools (notes, maps, etc.) to provide direct support for the student. The advantage of technology was that she could program it into the computer and thus be able to help all of her students at once. However, as evidenced by the research on TELE-Web, CSILE, and other technologies, the more knowledgeable other may also be other students working with the same innovation. Research suggests that when children collaborate, they can and do scaffold each other's thinking as predicted by Piagetian and Vygotskian learning theories (Roschelle, 1992; Tudge, 1992). This is an extremely important point because for the most part, children spend far more time in direct interaction with their peers than they do with adults (Rogoff, 1994). [23]

Regardless of who or whom the more capable other is, technology can support the active construction of knowledge and eventually the taking over of the self-regulating adult role in the social learning relationship. Innovations that espouse active learning, collaboration, and social interaction also offer opportunities for new types of relationships between teachers and students—least of which is the proverbial move from 'sage on the stage' to the 'guide on the side' (Batson, 1993). Finally, as "learning occurs through centripetal participation

[23] A third potential role for the computer is to actually act as the more knowledgeable or more capable other. That is a role worth mentioning, though it is highly debated. Although one can see the potential in programs that 'teach', it is arguable whether it is the computer acting as the more knowledgeable other or the teacher and other participants (students, audience, software author, etc.) acting *through* the medium. (See (Linn, 1991).)

in the learning curriculum of the ambient community" (Lave & Wenger, 1991), innovations become promising tools insomuch as they provide space for the creation of learning communities. Those communities, places where students can try out ideas and challenge the ideas of others, are both supported through and emergent from interactions with technology such as computers (Krajcik, 1994; Resnick, Rusk, & Cooke, 1999).

Like TELE-Web and Cognitively Flexible Hypertexts, active participation, collaboration, and social interaction were important features of the "Got Milk?" project. We decided that during the individual study time, the teachers would meet with one group to learn more about what they wanted to do (and later on, what they had done and what they had found out). Danielle and Elizabeth would then develop instruction that would help the group (and the class) learn the skills associated with the group's plans. For instance, the 'evidence group' wanted to visit the lunchroom to count the number of milk containers being thrown away. Students in this project would learn how to collect, organize, and display their data. Danielle and Elizabeth taught the entire class different ways to collect information. After the 'evidence group' had returned with their data, the teachers engaged the entire class in math skills needed to translate their raw data into graphs, charts, and conclusions.

The 'information group' was responsible for gathering information related to the use and waste of milk. In this process, the group learned about the production of milk. Danielle and the group members then taught the rest of the class the science behind the physical and mechanical production of milk. This

approach turned the two-to-three day "Got Milk?" movie into a thematic unit, encompassing math, science, social studies, history, language arts, art, music, and theatre. [24] Danielle shared her thoughts on tape one day:

> The students generated all of the ideas for the movie. However, we began to realize that if we wanted to make their dreams come true, we as teachers needed to plan. So, we made a schematic map based on their ideas. We began to think about how it would fit into different curricular strands. How would it fit into math? How could we support it with social studies values?

The teachers designed a curriculum around the students' ideas that supported multiple curricular elements. Students learned mathematical and analytical skills of problem solving, data collection, and data representation. This included creating and using tools to verify their hypotheses, putting the data into graphic form, and reflecting on what they had seen. They honed their language arts skills through speaking, reading, writing, listening, brainstorming, conducting interviews, and debating. In social studies and geography, students communicated with others from around the world (mainly Australia and Africa) to discover whether the problem was global or local. In doing so, they discovered that many children did not know where milk came from or thought that milk only came from cows. In science, they learned about how milk was produced, what animals produced it, and how dairy farmers processed it. Other lessons focused on history (the history of milk production, the history of dairy animal use in

[24] Thematic units are sets of learning experiences surrounding a central question. These themes (bats, whales, milk wasted, etc.) allow students to explore a topic from a variety of perspectives. Much like the argument behind Spiro's Cognitive Flexibility Theory (Spiro et al., 1988), multiple passes at the same content from different perspectives affords a more comprehensive approach to the material. Moreover, it allows students to see connections between content areas.

America, etc.), art (how to create posters, how to design web pages, etc.), music (the creation of a 'jingle'), and theatre (acting, directing, producing a movie, etc.).

Potentially one of the most interesting things related to active participation and collaboration happened when a student searched for information on the web. The very first page was entitled, "Why milk is bad for you." This student shared with the rest of the class information he had learned from this research. Mainly, he found that people can be allergic to milk, and others are against drinking milk for health or religious reasons. After he shared this, a few students admitted to being allergic to milk. They later confided that they hadn't revealed this before because the focus had been on 'how cool it was' to drink milk. Students used critical thinking skills to decide that, since people have different reasons for not drinking milk, the focus should shift from 'drinking milk' to 'not wasting food or milk.'

In each of the examples above, students actively participated in the design of the curriculum and content. The social interaction, especially in the last case of the "bad milk" was important to challenge the preconceived thoughts and notions of the students. However, the technology was important in supplementing both of the participation and the social interaction. It helped connect students with experts from around the world. They also used chatrooms to post their thoughts with members of the class. According to the Danielle, they built a local community of experts online—a place where students could test out their conceptions of how milk was made, where it was used, and how it was wasted.

Furthermore, using technology allowed them to approach the same problem in a variety of ways. Using the criss-crossed landscape method described in Cognitive Flexibility Theory, students learned about the waste of milk through studying science (the production of milk), mathematics (graphing waste), history and social studies (the impact of milk production and history of its use), language arts (argumentative essays for and against the use of milk as well as interviews), and geography (locating the places milk came from). However, they also used a variety of technologies to explore those issues including: chatrooms, PowerPoint, word processors, email, web searching, and video and audio production.

The Creation of Artifacts

The "Got Milk?" project began with a brainstorming activity on how the students could best 'reach a chosen audience.' The students and teachers talked about what they could create to share their message of the importance of not wasting. The movie was chosen; however, as mentioned earlier, all of the student ideas were eventually used in the production of the CD-ROM. This was important as it helped each student gain a sense of ownership. It was also important, though, because good innovations must offer a variety of opportunities for the creation of real solutions and artifacts in response to those problems. Michael Cole (Cole, 1996) states: "an artifact is an aspect of the material world that has been modified over the history of its incorporation into goal-directed human action" (p. 117).[25] In social constructivist thought, these artifacts are

[25] Cole, drawing on Marx Wartofsky, distinguishes between three levels of artifacts. Primary artifacts are ones used directly in production such as axes, needles, and bowls. Secondary artifacts are representations

integral and inseparable components of human functioning (Engestrom, 1991; Prawat, 1996).[26] The creation of those artifacts allows students to learn concepts, apply information, and represent knowledge in a variety of ways (Blumenfeld et al., 1994). Those artifacts, in turn, represent students' understanding of the problem, resulting solutions, and emergent states of knowledge (Krajcik, 1994).

One prime example of the technology-supported creation of artifacts is Project Based Science (Krajcik, 1994). In Project Based Science, "the computer provides access to data and information, expands interaction and collaboration with others via networks, promotes laboratory investigation, and emulates tools experts use to produce artifacts" (pp. 488-489). Technology is integral to the project not only because it helps to produce artifacts (artifacts that emulate what an expert might create) but because of the variety of ways in which students can create artifacts. Artifacts are representations of student knowledge and understanding; as such, students must have various, diverse opportunities to create them. In Project Based Science, opportunities exist to easily construct, manipulate, and revise video, audio, text, and graphics (p. 489). [27]

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of primary artifacts. Recipes, constitutions, and norms are examples at this level. The final level consists of imaginary artifacts that come to constitute a relatively autonomous world. Tertiary artifacts color the way we see the world; examples include works of art and processes of perception. See *Cultural Psychology* (Cole, 1996) for a more comprehensive description of Wartofsky's levels.

[26] Another definition or version of artifacts comes from Jerome Bruner (Bruner, 1996). Drawing on the French cultural psychology, Ignace Meyerson, Bruner calls these artifacts *oeuvres*. *Oeuvres* are "works that, as it were, achieve an existence of their own. In the grand sense, these include the arts and sciences of a culture, institutional structures such as its laws and its markets, even its 'history' conceived as a canonical version of the past" (p. 22). Minor *oeuvres* also exist as local, modest, identity-bestowing traits.

[27] Working with these various tools, in turn, prepares students to participate in the 'information age' (Zhao et al., 2000a).

Students in Danielle's class saw a variety of possible solutions to helping others learn about their problem (wasting milk). The technology offered opportunities for those students to express their solutions to those problems. The CD-ROM was the largest artifact, but as a part of that product, students also created and produced movie segments, recorded and live speeches, PowerPoint presentations, scanned images, milk chatrooms, and digital images of the problem and potential solutions. After spending time researching the problem in the library and on the Internet, students discovered that their created artifacts represented many of the same efforts made by experts in the field—experts in both dairy farming ('enlightening' the public) and the problems of waste.

Publication, Reflection, and Feedback

Although each "Got Milk?" participant focused on a different part of the campaign, they all had the opportunity to learn through others. This meant that the students helped the instructors teach their specific section (mathematics and graphing, art and web design, etc.). However, it also entailed sharing what they had learned from completing their section (both the artifact of the endeavor as well their secondary artifacts throughout the process). They shared with their classmates and, in the end, shared with a larger audience through the publication of the CD-ROM and visits to other classrooms, the technology conference, and the City Council meeting. Students from other classes, judges at those conferences, parents at PTA meetings, and reporters from local news stations all spent time sharing feedback with "Got Milk?" participants. They wrote letters,

email, and made personal visits to share the impact the students' work had on their lives.

Students having a chance to *publish, reflect, and receive feedback* on their efforts is essential to a social constructivist model of learning because of what Rom Harré (Harré, 1984; Harré, Clarke, & DeCarlo, 1985) has called the 'Vygotsky Space.' His representation helps clarify how learners "move from using new meanings or strategies publicly and in interaction with others to individually appropriating and transforming these concepts and strategies into newly invented ways of thinking" (Gavelek & Raphael, 1996). The Vygotsky Space defines and describes four recursive processes within the individual-social and public-private dimensions: appropriation, transformation, publication, and conventionalization.[28] Although all of the Vygotsky Space processes were evident in the "Got Milk?" project, publication was the most salient.

Publication is the process in which student knowledge, understandings and strategies are made public so that others can respond. Artifact creation and the opportunity for publication are important ingredients in good innovations for three reasons.[29] First, through publications, teachers and researchers "can infer the process by which students transform meanings and strategies appropriated within the social domain, making those strategies their own" (Gavelek & Raphael, 1996) p. 188). Second, publishing makes material accessible to subsequent

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[28] See (Gavelek & Raphael, 1996; Harré, 1984; Harré et al., 1985) for a complete explanation of the Vygotsky Space.

[29] Artifact creation and publication essentially sound like the same process—that of producing representations of knowledge and understanding. One of the core differences is that artifact creation can either be material or conceptual, especially in the secondary and tertiary levels. Publication, conversely, refers to representing that understanding in forms others can see, hear, feel, etc. In the Vygotsky Space, publication takes form as knowledge moves from the private to public sphere.

reflection and analysis, allowing students to revisit and revise their artifacts, thus enriching the learning experience (Bruner, 1996; Krajcik, 1994; Olson, 1994; Olson, 1998).

A third reason publication is important refers back to the need for a good innovation to consist of challenging, academic content at the high end of the Zone of Proximal Development. Assistance from a more capable or more knowledgeable other in the ZPD is referred to as scaffolding (Wood, Bruner, & Ross, 1976). "Scaffolding characterizes the social interaction that occurs among students and teachers that precedes internalization of the knowledge, skills, and dispositions useful for all learners" (Roehler & Cantlon, 1996). Publication offers the opportunity for feedback; feedback, in turn, scaffolds a learner in their quests for knowledge construction, knowledge integration (Linn, 1991), higher-order thinking, and self-regulatory behavior. [30]

A Discussion of 'Good Pedagogy'

Research presented in this chapter provides evidence that authentic and challenging content, active participation (including collaboration and social interaction), a sense of ownership, opportunities for the creation of artifacts, and publication (promoting reflection and feedback) are all necessary features of good pedagogy. Good pedagogy, in turn, is a requirement for good technology innovations. The benefit of this relationship is the fact that many technologies, as

[30] Another excellent example of technology-supported publication of artifacts and scaffolding through feedback is the Reading Classroom Explorer (RCE) (Ferdig, Hughes, Packard, & Pearson, 1998). RCE is a web-based tool created at Michigan State University's College of Education. It was designed to engage teacher candidates as actively as possible in learning about literacy instruction. Students use RCE to create and publish a variety of artifacts including notes, papers, and discussion forum messages. RCE is available on-line at: http://reading.educ.msu.edu/rce

corroborated by educational inquiries documented in this chapter, are flexible enough to support the components of good pedagogy. Thus, a reciprocal relationship exists in which good technology innovations require but also have the potential to support and sustain good pedagogy. At this first level, good pedagogy turns innovations into pedagogical, cognitive tools that scaffold students and support learning (Salomon, 1993; Scardamalia & Bereiter, 1991). Three questions regarding good pedagogy and technology innovations remain, however:

a) Are these the only five factors that assure sound pedagogy?
b) In any given technology integration, must all five components be evident to assure sound pedagogy?
c) What about successes in educational technology innovations that were not designed or planned?

Are these the only five factors that assure sound pedagogy? Research provides evidence that the five components listed above, when present in a technology innovation, help to ensure the innovation is sound from a social constructivist perspective. The use of only five factors does not necessarily imply that these are the only components that make up a pedagogically sound innovation, for three reasons. First, as evidenced in the literature, other research has documented many of the same findings but with different labels (Blumenfeld et al., 1994; Krajcik, 1994; Zhao et al., 2000a). Some have separated many titles I've joined; others have joined categories I have separated.

Second, I argue in this dissertation that we need a deeper psychology of technology. The call for depth implies drawing vocabulary from disciplines such as psychology to gain a more comprehensive understanding of the instance of

technology use. Thus, I would hope continued exploration would drive the discovery of other necessary factors. In conjunction with Sarah and her eMate, research might suggest that educational technologies need to be designed to act as transitional objects for younger students. Or, drawing from Cognitive Flexibility Theory and Cognitively Flexible Hypertexts (Spiro et al., 1988), we might learn that hypertext is an important design factor in all 'good innovations.'

Third, different pedagogical goals have different needs associated with them. For instance, research may suggest that teaching visual learners requires innovations that are more pictorial in nature. Or, research might suggest that students need on-line calculators to facilitate their mathematical learning in some online learning environments. Important 'secondary' factors exist, therefore, in the design and implementation of the innovation related to the specific goal of teaching. That does not mean, however (at least not yet), that every innovation has to provide access to pictures and calculators to be considered pedagogically sound. These secondary factors are potentially related only to the pedagogical goals of the curriculum or environment in which the innovation is to be implemented. Conversely, at this point in educational technology's young history, research on learning theory and technology *has* supported the five aforementioned 'broad' factors as important in assuring pedagogical sound innovations, regardless of what pedagogical goal you are trying to accomplish.

In any given technology integration, must all five components be evident to assure sound pedagogy? The idea behind a good innovation requiring good pedagogy is that the technology should support what we know about how

students learn. As documented by this dissertation, the five components are integral parts of a social constructivist learning theory. Thus, to leave out one or more would leave you subscribing to half of the theory. A technology innovation that claims to espouse a social constructivist approach and yet does not support artifact creation or active learning is not pedagogically sound. In turn, an innovation that is not pedagogically sound is not a good innovation.

This argument extends to claim good pedagogy is required regardless of the learning theory one subscribes to. Thus, a Piagetian individual constructivist approach might not have the exact same factors, but would still require the innovation to match the learning theory in order to be considered 'good.'

What about successes in educational technology innovations that were not designed or planned? In the history of educational technology innovations, there are examples of technologies that have transformed a learning experience even though there was no pre-stated, preconceived or premeditated design. For instance, one teacher I worked with used group reading in a lesson on social studies. The students reacted very emotionally due to the content of the book, and asked the teacher if they could write out their feelings using word processors in the classroom. The students used the word processors to type out their essays, and then shared their writing on-line with other classes. This experience was imbued with artifact creation, social interaction, publication, feedback, etc. It provided evidence supporting social constructivist theories of learning, and yet it was not initially designed based on that (or any) learning perspective. Does this

imply that using the word processors was a bad innovation because it was not designed, let alone designed with pedagogy in mind?

One reason I find technology fascinating is because of its ability (or our ability through mediation) to be represented in multiple ways. For instance, a laptop is a word processor to some people, a projection utility to others, and a CD audio or DVD movie player to still others.[31] Somewhere in his approach is the notion that regardless of the pedagogical design we build into educational technologies (or the lack thereof), students find other (potentially important) uses for them. Or—another way to put it—the pedagogical use of technology, especially in the classroom, is not always a pre-calculated event. Thus, in the instance of the teacher and the word processors, it was important for her to revisit and reflect on the instruction to understand the pedagogy and technology behind the experience. Furthermore, it highlights the fact that good technology innovations require more than just good pedagogy; they require good people and good psychology. These additional components, discussed in the next two chapters, help us understand what it takes to adapt the technology to the curriculum (and vice versa), what characteristics certain technologies have that might make them more or less conducive to teaching and/or learning, and the unintended consequences of technology use.

Good Pedagogy and More

The "Got Milk?" project was a successful technology innovation, at least in part, because it used good pedagogy to scaffold the learning of authentic,

[31] This varied mediation of tool use occurs outside of technology as well; a perfect example is Cathy Davidson's *36 View of Mt. Fugi* (Davidson, 1993).

challenging, academic content. Students used technology to actively participate and take ownership of a project they had designed. They also used technology to create artifacts to solve problems unearthed during their inquiry. In turn, they learned how to be problem-solvers and critical thinkers.

Chapter 2: The People Behind "Got Milk?"

Introduction

> The Magic Everywhere
>
> I see snow on the trees and I see white snow on roofs of houses. I see snow on the ground covering the grass and I see marshmallows on chocolate. I see some cookies with some white sprinkles I can taste in my mouth. Can you feel the magic and taste the magic in the air?
>
> By Alannah (age 9)

What do we really know about technology and education? We know that *a good technology innovation is one that views implementation as a process catering to the relationships between innovator, educator, and learner.* In the last chapter, I presented research that demonstrated evidence of the necessary but potentially reciprocal relationship between technology innovation and pedagogy. That first requisite highlights technology innovations as tangible hardware or programmed software that act (at least in one manner) as cognitive tools. They scaffold and support students' learning and student learning environments when they are permeated with good pedagogy. However, a good innovation is also a process of creation, implementation, and use by innovator (developer), educator, and student.[32] A good innovation is consequently defined in relationship to *what it is* as well as *how it is implemented.*

[32] Sometimes, as will be mentioned here and discussed in greater detail in the next chapter, those three can be the same person. This is due to the fact that we all use technologies in different, new, and exciting ways for a variety of reasons. As mentioned earlier, a laptop to one person is a database management tool. To another person, it is a CD-ROM audio player.

A third grader named Alannah, a "Got Milk?" member, wrote the poem above, entitled "The Magic Everywhere." It had just snowed for the first time that winter, and she was thinking of ways to express her feelings about the 'magic she felt.' The web-based software she used to write the poem was specifically designed with good pedagogy in mind. In order to write the poem, Alannah had to log in to the system and create her own project, thus giving her a 'personal space' and a sense of ownership. She created for herself an authentic task of trying to share her perceptions with others on the web-based system. In writing the poem, she created and used other artifacts such as notes, prompts, and diagrams. She then published the poem and received feedback from her teachers and colleagues.

The innovation (software) afforded the opportunity for learning because of *what* it was—a technology steeped in good pedagogy. However, the history of the innovation tells a more complex story than Alannah merely walking up and typing in the poem. The teacher wanted a tool in the classroom to support the development of her students' writing. She contacted the developers, who began by trying to easily and efficiently develop flexible, pedagogically sound software. The teacher then spent time with the developers, learning the software and helping to further craft the system to her educational needs. During the implementation stage, the teacher worked with students in the classroom and adapted her curriculum to integrate the new technology. At that point in time, Alannah was able to use the innovation to share her magic.

This vignette of an innovation implementation demonstrates that a technology innovation is more than just a hardware and/or software product—it is also a process. That process is not just a matter of the amount of time it takes to develop the product; rather, it is also a matter of how the product is implemented (developed, put into practice, taught, etc.) over time. That process can best be defined as a collection of relationships between the members involved in the innovation, namely students, teachers, and developers. Therefore, a good innovation, in addition to requiring good pedagogy, also requires good people.

What does it mean to have an innovation that is implemented by good people? It means having:

1) Innovators who recognize the dialogic nature of innovation implementation.
2) Innovators who interact with teachers and students in genuine ways.
3) Innovators and teachers who understand the flexible nature of both teaching and technology.
4) Innovators who provide opportunities for legitimate participation.

Who are the members of an innovation?

A good innovation requires good people. 'Good people' refers to the members who are a part of the innovation development and subsequent integration and use. Those members include innovators (developers), teachers, and students. Prior to a more complete description and explanation of the necessary relationships between the three groups, it is important to define specifically the roles of each of the members/groups in an innovation.

The first group is named 'innovator' and/or 'developer'; the two terms are used interchangeably in this text. [33] Sometimes this person is described as the 'technology expert.' The role of this person (as defined here) is to use computer technologies in novel, creative, original, and advanced ways to enable a different or more productive teaching and learning experience. This can involve the development of new tools or the innovative uses of existing ones. The second group is labeled 'teacher.' As the title would suggest, this is a person who instructs the third group—the student. However, this is also the person that works with the developer to integrate the innovation into the curriculum. Finally, 'student' is the label of the third group; it refers to the person who is using the innovation to learn.

It is important to note that these labels of teacher and student do not necessarily correspond to the same labels as they are used in classrooms. The titles are based on the functions or tasks the individuals perform. Thus, a developer may be the classroom teacher, an outside consultant, a researcher, or even a classroom student. Conversely, a teacher might refer to the classroom teacher, a classroom student teaching a peer, or the developer (working in the classroom). And everyone plays the student role at some point or another; they all use the innovation to learn.

The People Behind "Got Milk?"

The milk video was a successful innovation because it provided students with the opportunity to use technology to accomplish curricular goals—goals that

[33] One could make the claim that a developer actually creates hardware and software where an innovator uses the development in inventive ways. However, for purposes of this text, the two terms are not differentiated.

were derived from good pedagogy. The innovation was also successful because of the people behind the project. The fact that parents, other teachers, local university representatives, family members, and administrators (district and local) supported the project says something about the power of this innovation to impact not only teachers and students but a wide community of peripheral participants. However, I'm specifically referring to the people who enabled this technology innovation to be implemented in the classroom: Danielle, Elizabeth, and myself. The necessary relationships among the three of us (as teachers, students, and innovators) are explained below.

The Dialogic Nature of Implementation

There has been much debate in the field of educational technology regarding the relationship between technology innovations and established practice (Bromley, 1997; Bruce & Hogan, 1998; Bruce, Peyton, & Batson, 1993). One side views technology innovations as having the power to fundamentally transform existing practice (Fishman & Pea, 1994; Papert, 1987). The other side contends that teachers' beliefs, school bureaucracy, and other established practices retard, sometimes even negate, the potential impact of technology innovations (Cohen, 1987; Cuban, 1986).

Good innovations require *developers who understand that technology implementation is a bi-directional dialogic interaction between innovation and established practice* (Cziko, 1995; Hawkins, 1987; Zhao et al., 2000a; Zhao, Mishra, Worthington, & Ferdig, 1999). "In this view, neither innovation nor existence is considered the independent variable. Instead, both are independent

and dependent variables, causing changes in each other simultaneously" (Zhao, Worthington, & Ferdig, 1998, p.2). This dialogic interaction can be thought of as a 'negotiation' or 'improvisational dance' between the teacher and developer, with each bringing something special to the relationship (Cliff & Miller, 1997). The teacher brings knowledge of pedagogy, academic content, and pedagogical content knowledge (i.e., how to teach, an understanding of mathematics, and how to teach that understanding of mathematics). That knowledge helps developers create innovations imbued with good pedagogy. The innovator brings cognitive tools that support teaching and learning as well as a more complex understanding of the potential uses of technology. The concept of negotiation reminds both groups that they are entering into a dance, with the intended outcome being a recursive, dynamic creation of technology that supports pedagogy and pedagogy that is fundamentally changed by virtue of its integration with technology.

As expected, this project took the time and effort of all three of us. Danielle and Elizabeth had to ensure that what the students wanted to do was tied to the curriculum. In other words, they had to provide the space to complete this project. For starters, they had to expand the time and energy it took to create a thematic unit over an extended amount of time. Furthermore, when students worked in groups, they had to connect what the groups were learning to the thematic unit. This entailed teaching small group lessons to the entire class, and then using the outcome of the small group work as data in response to that learning.

Collaboration was also essential. We needed one person in the room to oversee small group activity while another taught the larger group. We had to decide what activities would support the "Got Milk?" campaign while other students were filming. Cooperation and social interaction was also required on the part of the students as they directed, filmed, or even sat quietly while filming was taking place.

My role initially was that of a participant observer (Hammersley & Atkinson, 1995). In other words, although I was a part of the classroom, my role was designed to mainly observe while the students and teachers used technology. However, although I started as this 'peripheral researcher,' I ended as a complete member researcher (Adler & Adler, 1994). I was converted to genuine membership during the course of my research because of the need for technical skills. Although Danielle was recognized as being very proficient, experienced, and knowledgeable about technology, some of the things we were doing in the class were new to her. This included helping the children film, edit, and burn (record) their movie.

Although Danielle was the main teacher in the classroom, this project occurred during the lead teaching time of Elizabeth's internship. Thus, Danielle acted as a developer and innovator as much as she did a teacher. In developing this project, we met with Elizabeth almost daily to understand what she was trying to accomplish in the classroom, and how technology could enable that teaching. Danielle knew more about teaching, and I knew more about technology. As a tandem we were able to provide Elizabeth with insight and

advice on what technology could do to help her achieve her specific pedagogical goals. Elizabeth, in return, would report on what was working and what wasn't, what she wanted more of and what needed to change.

The interactions described above among the three of us and the students might make it sound like 'technology as innovation process' refers to the time and effort it takes to carry out a project. Or, it may appear that a good innovation requires nothing more than knowledgeable people experienced with teaching and technology. Both of those, of course, are essential. However, the process lives or dies depending upon the relationships between the people. Even when knowledgeable people work together, it might fail because the relationships among them are not educationally legitimate interactions. Legitimate interactions, as described above, are those that are dialogic, genuine, and reveal the flexible nature of both teaching and technology.

Genuine Interaction

With some innovations, the technology expert (developer or innovator) is also the classroom teacher. However, in numerous cases, the developer or innovator comes from outside of the classroom. This could include district or school technology coordinators, volunteers from local businesses, or educational researchers examining the effectiveness of new technologies and innovations. External specialists can be extremely important to the success of innovations, especially if the teacher is uncomfortable with technology to begin with (Chaney-Cullen & Duffy, 1999). However, additional responsibilities are placed on the technology expert from outside of the classroom in implementing a good

innovation. Namely, *developers must understand the significance of genuine interaction with teachers and students.* If an expert is to help implement the innovation in the classroom, he or she faces a challenge the teacher does not originally have: when the teacher is the innovator, students have already developed a rapport with the person integrating the technology. This rapport is important for innovators entering the classroom because building connections with students helps to develop a community or culture of learning to which the innovation is to be introduced (Rowe, 2000). As described in social constructivist pedagogy, this community promotes learning as students participate in shared endeavors with others (Brown, 1994; Rogoff, 1994).

Moreover, understanding student concerns and histories allows for a better explanation of technology implementation in the classroom (this is also an important effect of good psychology, described in the next chapter). In the story that began this chapter, the researchers thought there might be some component of the technology, her learning style, or the interaction of the two that prevented Alannah from using the computer as a cognitive tool for writing. Once rapport developed between the innovator and Alannah, she revealed that she had never used a computer before and was afraid of what might happen if she used it (what she would 'mess up', etc.). Once she trusted the innovator, she trusted the innovation.

In order to enter into the dialogic interaction and negotiation of implementation, technology experts must also develop a relationship with the teacher(s) in the classroom. Most in-service technology training models,

generally in the form of short-term after school programs, fail to provide teachers with the opportunities or the knowledge they need to successfully implement technology into their curriculum (Murray, 1995). Murray (1995) describes four characteristics of good technology developers and innovators including: a) being peers of who they are training; b) being effective teachers who can translate technical information to learners of different levels including novice; c) being patient tutors without succumbing to taking over the keyboard; and d) being available to answer questions promptly.

Genuine interaction with teachers and students is a necessity of a good innovation because: a) the developer acts as the more knowledgeable other in the learner's Zone of Proximal Development, thus supporting good pedagogy; b) interaction facilitates collaboration and social interaction, which helps to sustain the community of learners; and c) interaction fosters rapport between the members of the innovation. By building rapport, technology experts enter into a more dynamic and comfortable 'improvisational dance' with the existing participants and practices of the classroom. The role of the technology developer or innovator is highlighted as someone who supports teacher and student learning by actively participating with the classroom participants in the innovation rather than consulting at a distance.

Genuine interaction was a necessary and evident part of the "Got Milk?" innovation. Although the teachers had worked with the students for a few months, I had only gotten to know them a few days. I had to spend a lot of time listening to their stories, learning more about *Pokemon*, and even jumping rope

before I gained their trust. This trust and personal relationship, in turn, allowed me to "pull out spontaneous expressions from the students and augment their creativity"—at least that was the conclusion reached by Danielle and Elizabeth. The teachers were developing their own working relationship, which grew largely out of the interactions of Danielle teaching Elizabeth about technology and teaching. Elizabeth revealed this during one of our meetings:

> Danielle is a good collaborative teacher for me because she is very positive, delicate, and gentle. I can see what she is doing when she does it to me because I watch her do it with the kids, but it works for me. We have other interns right now who are ready to quit because they've been verbally abused; they've been treated horribly.

The Flexible Nature of Teaching and Technology

An important component of the implementation and negotiation process is genuine interaction between the participants. This genuine interaction builds rapport and helps the members develop shared understandings of the knowledge, skills, and dispositions they bring to the dance. For a developer, one important understanding is the *flexible nature of teaching*. Learning, from a social constructivist perspective, is always improvisational and adapting to immediate, constantly fluctuating circumstances. Therefore, teaching requires continual learning, adaptation, improvisation, and instant decision-making (Becker & Riel, 1999; Engestrom & Middleton, 1996).

Teachers require innovations that are adaptable enough to meet these changing demands of the classroom. Part of this need can be alleviated when developers help teachers understand *the flexible nature of technology*. In other words, PowerPoint to one teacher is a presentation tool at PTA meetings; to

another teacher, it is a way for students to tell a story. One teacher might use a video camera to record and then reflect on her teaching; for another teacher, the camera provides a way for students to reflect on their learning. Teachers and developers need to understand that even with technologies designed for specific purposes, users will create their own rationale and functions for its use. This chameleon-like flexibility of technology, once appreciated, is a very useful feature, especially for teachers who might be limited by the amount of technology they have access to. (As described in the next chapter, it is also important in assessing the impact of the innovation.)

However, developers can also design the implementation to facilitate and support the flexible nature of teaching. This design, called component architecture, focuses on producing reusable and context independent software units (Zhao, Mishra, & Ferdig, 2000b). Specifically on the web, a designer can implement multiple, interchangeable modules to meet the educational goals of the teacher, rather than developing thousands of lines of code each time a new need arises. An example includes the aforementioned TELE-Web project. It uses server-side software (mail, video, and web servers, etc.) and client-side plug-ins (JavaScript, Java applets, Shockwave, etc.) to offer an integrated suite of multi-functional tools for teachers and students. However, all of the tools are small modules in and of themselves. Chatrooms, space for writing notes and papers, diagram and mapping instruments, and classroom videos are all separate components that can be exchanged, combined, or separated when a new educational need arises.

A major benefit of this approach for developers is the opportunity to easily and inexpensively create flexible and pedagogically sound software by adapting 'modules' to different purposes and applications. Many of the components necessary for web-based learning environments are available pre-packaged and free over the Internet. The component architecture design also facilitates the negotiation process between the developer and teacher. If a teacher finds a component that does not fit her pedagogy, she can easily replace it with another without having to throw out the entire innovation (Zhao et al., 2000b). Furthermore, the teacher can play a more significant role in choosing the modules because she no longer has to know how to program in order to make the components work.

A good innovation requires *developers and teachers who understand the flexible nature of teaching and technology*. For developers (and teachers), this understanding entails realizing that users create their own functions and reasons for using any given technology. Developers can also facilitate the process of negotiation by creating technology innovations that are based on interchangeable components. In doing so, they also help *teachers appreciate the flexible nature of technology*.

The project itself demonstrates the flexibility of teaching and technology. The project was student developed; it was a creation of an authentic problem they discovered, and it changed daily based on what the students were learning from their investigations. (In describing what she had learned from Danielle, Elizabeth suggested that many teachers would have sent the students away with

a lecture about the perils of waste.) This constant need for change created tasks, spaces to be filled that could be filled by technology. The Internet was used for research one day, and then for email the next. The movie camera filmed the students' interactions for the teachers and researchers one day, and then was used by the students as a tool for reflection the next day (the students videotaped each others' speeches and, upon reviewing the tapes, made suggestions for improvement). In other words, the technology worked because it was not seen as limited to only perform a small number of tasks. Moreover, a variety of tools were used so that if a particular tool did not work, the project did not close down. Instead, a new tool was found to fill that role. Or, as in this case, the technology was used for a different purpose. We were able to move from one tool and purpose to another because the three of us were in constant dialogue.

The best example of this flexibility in the "Got Milk?" classroom was the use of PowerPoint. PowerPoint is software from Microsoft that is advertised as a tool to organize, illustrate, and present ideas. Most people use (and are taught to use) PowerPoint as a visual aid in face-to-face presentations. Combined with projectors, outlines or highlights of presentations are sent to a large screen while the speaker is sharing his or her thoughts and ideas with an audience.

In the past, Danielle had used PowerPoint and a projector to present lesson plans to the class. She also instructed students how to use PowerPoint so that they could make their own presentations of stories they had developed or library research they had completed. When Elizabeth met Danielle during the

summer before her internship, Danielle had suggested that she learn PowerPoint so that she, too, could present lessons to the whole class using the projector.

Even though she used PowerPoint extensively, it came as a surprise to me that Danielle suggested the software to solve Elizabeth's problem. Elizabeth wanted the students to create posters about the use and waste of milk. She foresaw them using the posters as a visual tool to share their ideas with other classes. However, Elizabeth wondered, how could the posters be preserved in the CD-ROM? Danielle thought that digital pictures of the students and their posters could be captured and put into a PowerPoint presentation, and then added to the CD-ROM. That, in some small sense according to Danielle, would best represent the students' work to 'readers' of the CD-ROM—those not fortunate enough to see the children perform in person.

As suggested in an earlier chapter, neither Elizabeth nor I had conceived of PowerPoint as a way to present hand drawn work. Furthermore, it solved a technical problem for me as developer. I was not sure how to guarantee every CD-ROM user would be able to view the pictures. By turning the pictures into a PowerPoint presentation, we could include 'viewers' with the CD-ROM so that every user would have access to the student work. Once we had been introduced to the idea, I then suggested that PowerPoint could be used to record voiceovers. Thus, the students could actually read and record the text on their posters. When a user 'flipped' to their poster, the child's voice would read the poster text to them. I left earlier than the teachers that day as they were both excitedly discussing other ways in which this new combined use of PowerPoint

could be advantageous in other curriculum objectives. The point is that if we had stuck to a very conventional understanding of the technology, we would have been limited in our ability to represent the flexibility of teaching and learning that took place in the "Got Milk?" classroom. Moreover, the new and improved design of the posters provided an innovative way to teach and share student ideas with others (CD-ROM users) even though it was not in a face-to-face environment.

Opportunities for legitimate participation

If an innovation is to work for all participants, it must *provide opportunities for legitimate participation.* Legitimate peripheral participation, a term coined by Lave and Wenger (1991), means offering chances to co-participate in the practices of the ambient community, with the end goal being full participation in that community. "Moving toward full participation in practice involves not just a greater commitment of time, intensified effort, more and broader responsibilities within the community, and more difficult and risky tasks, but, more significantly, an increasing sense of identity as a master practitioner" (Lave & Wenger, 1991, p.111).

Earlier, I made the claim that the roles of the three groups grow, change, and develop. Because we all had similar goals, legitimate participation with good pedagogy allowed all of us to learn both the content (what was being taught) and the process (the way in which it was being taught). The teachers helped adapt technology to their teaching to create a pedagogical tool; in doing so, they also learned how to use technology to enable and transform their teaching. For instance, the students wanted to create a movie. The teachers shaped the

movie such that it would contain content that could be used to important lessons in mathematics, science, and geography. In helping the developer adapt the idea of a movie to the curriculum, they learned about new and exciting ways to teach those same topics. Danielle commented on the importance of using the Internet to actually talk with people from the lands they were studying. Elizabeth talked about the benefit of using a graphing program to help students understand how to plot data. Although both of these were tools that were used to create the movie and CD-ROM—tools that the teachers had helped revise and fit the curriculum—they occasioned learning experiences for the teachers.

I also played the role of the student as I attempted to create a pedagogically sound tool. In doing so, I learned more about teaching and pedagogical content knowledge. I was familiar with the use of video, but I did not fully understand the potential of having students record themselves and replay their performance. Not only were they able to practice public speaking, they learned from their performance. They were able to see their own mistakes and accomplishments. Michael asked, "Do I really talk that way?"

Finally, the students were able to learn the academic content while exploring how to teach others, how to become more self-regulatory learners, and how to use technology. Upon returning from their group time, they had the task of sharing the information they had learned with others. Students became the experts or more knowledgeable others in certain topics and were looked up to by their colleagues to teach specific topics. Charles became the 'web expert.' He had visited many web sites in Australia (virtually, of course) and shared the fact

that many students in Australia "did not know where milk came from." Elizabeth described this 'diverse' learning as follows:

> I want students to know that I'm a human being. I want them to know that even though I'm the teacher and I have some authority, I'm still a learner. I don't know it all, but I may know more than they do regarding certain things. And, I'm sure they know more than I do related to other things.

A Discussion of Good People

'Good people' in a 'good innovation' has been defined as the community members (teachers, students, and innovators) who enact the technology and who understand necessary roles and relationships that exist between and among one another. The labels of the community members define the prototypic role each plays—not their official status within classrooms—and the actual tasks they perform in enacting the technology. Any one person can carry out more than one task, and any member can carry out any given task. This means that the teacher may also serve as the developer/innovator.[34] Or, a parent or another teacher could act as an innovator and teacher. Moreover, because legitimate peripheral participation entails mastery of skills and a growth of identity in the community of practice, a *good innovation is also one where the roles and relationships between members change.*

Up until now, I have specifically addressed the student as the one learning academic content through the innovation. However, the innovator or teacher is also a student. The developer learns academic content, pedagogical content knowledge, and rules about the community of practice from the teachers and students using the innovation. A teachers' identity changes from "educator" to

[34] This occurs numerous times in education either because the teacher has technology experience or there is a lack of funding to appropriate a 'technology position.'

"educator and innovator" as they learn to construct their own pedagogically sound, technology innovations. Or, a teacher could refer to a classroom student who has 'mastered' the skills of a technology and it teaching it to another student.

The argument is that to view the three types as members with clearly delineated roles with impermeable boundaries is to claim that members never adapt and never learn. Evidence suggests that members do switch roles and are more informed in making decisions (for themselves and others) about pedagogy, technology, and learning because of the interaction surrounding the innovation (Ferdig, 2000b).

Having said that, it does not imply the roles (mainly between teacher and innovator) will permanently merge. A person must have sufficient understanding of the academic content to apply and adapt technology appropriately. A person must also have sufficient understanding of the technology to know what is possible and how to implement that into the curriculum. In most cases, due to the amount of content knowledge in both fields, these are two different people called educator and innovator. Teacher training programs should still continue to support students learning the relationship between technology and curriculum, as long as it does not replace or neglect the learning of content or pedagogical content knowledge.

More than just "Good People" and "Good Pedagogy"

A developer provides opportunities for participation by seeing the implementation experience as dialogic in nature. This dialogue provides the space for the teacher's voice in the integration of technology and academic

content. A developer also facilitates involvement by having genuine interactions with both students and teachers. Genuine interactions support collaboration, community building, and social interaction—three important features of good pedagogy. Genuine interaction also implies providing guidance without seeming to take over; in other words, facilitating learning by acting as the more knowledgeable other in the Zone of Proximal Development. Finally, participation is supported by developing software that uses modules teachers can easily and inexpensively interchange and replace without having to have a deep understanding of the programming behind the tool.

"Understanding to be gained from engagement with technology can be extremely varied depending on the form of participation enabled by its use " (Lave & Wenger, 1991, p. 100). However, the three requirements of good people (those who recognize the dialogic nature of technology implementation, those who interact with participants, and those who understand the flexibility of technology), ensure student attainment of mastery level skills of both the academic content and the innovation implemented to scaffold learning of the content.

Creating a pedagogically sound technology innovation, amplified by people using the product in 'good' ways, allowed the participants to learn content while developing their identity as masters of the skills used in the community of learners. Good pedagogy and good people are not enough, though, to determine whether an innovation is good. The performance of the innovation, as defined by the learning gained and the development within the community of

learners, provides the final "P" required to more deeply explore, understand, and assess technology implementation.

Chapter 3: The Performance of "Got Milk?"

Introduction

> Once upon a time there were two brothers and they did not like each other; they fought all the time. But when they grew up, their father and mother died. The boys learned to work together and lived happily ever after.
>
> Arron (Age 9)

What do we really know about technology and education? Based on the evidence provided from the "Got Milk?" project, as well as claims from existing, relevant literature discussed in the previous two chapters, we know that good technology innovations are those that are integrated with academic content and good pedagogical practice. Furthermore, a good innovation is one that is a process catering to the relationships between innovators, educators, and learners. However, a good innovation is also one that produces *good performance*.

In the first chapter, research was presented that demonstrated evidence of the necessary but potentially reciprocal relationship between technology innovation and pedagogy. Good pedagogy described technology innovations as product. In the previous chapter, technology innovations were seen as processes; those processes, in turn, were described as the pedagogical relationships between the central people involved in an innovation.

Technology innovations were thus examined for *what they were* as well as *how they were implemented*, which helped define the question we were asking. In other words, if a teacher or educator wanted to assess a technology prior to its

use, pedagogy and personnel would be pre-requisites for answering the question, "Is this a good innovation?"

We change the meaning of the question dramatically, however, if we ask "Is this innovation good?" rather than "Is this a good innovation?" The latter question directs us toward criteria for evaluating 'goodness' from within the world of innovations (as innovations go, is this a good one?), but the former question forces us to look outside of the world of innovations—to appeal to some external standard for goodness. Instead of understanding what is important in the creation of a good innovation, we ask what results demonstrate that the innovation was good or successful. This question essentially examines the consequences, the outcomes or the performance of the implementation.

Arron, a third-grade member of the "Got Milk" project, wrote the short story that begins this chapter. Much like Sarah in the beginning of this dissertation, he was a struggling student who was given the opportunity to use the eMate. Danielle and Elizabeth made sure that he had assignments to go along with the use of the eMate. In the example above, the teachers asked Arron to write a story about conflict and struggle. They helped him when necessary, but let him tell his story in the way that he wanted, including drawing pictures to illustrate certain points (a function of the eMate).

We know that he used technology to write the story, and that the technology was both pedagogically sound and implemented by 'good people.' [35] Thus, it was a good innovation. But, was the innovation good? The story is the

[35] Saying 'good' to describe 'good people' makes it sound like I'm referring to some aspect of their character. Instead, I am describing the way in which they provided legitimate opportunities for growth in a learning community.

result, outcome, or performance of the use of the innovation by one student. What are the criteria that determine whether we judge this story as a good outcome? If I asserted that Arron was the best writer in the class, would that make this innovation good? Conversely, what if I stated that he didn't know how to spell and couldn't put sentences together? What if I divulged that his grades improved because of the use of the innovation, regardless of what you think about this story? Finally, what if we knew that he used the technology to tell a story about his relationship with his brother, which in turn allowed him to reflect and change his real relationship with him? Which of these sources of information helps us assess the 'goodness' of an innovation?

At some level, an innovation can be judged successful by meeting the required pedagogical goals laid out in the design of the innovation. Thus, if a technology is created to increase math scores, we can use certain tools to measure that goal. However, even if you design cases so that they are pedagogical sound, sometimes things happen that you don't intend. It should be obvious that we need ways to measure the success of an innovation just as much as we need methods to ensure quality design, development, and implementation.

Although a deeper psychology of technology refers more broadly to the relationships between pedagogy, people, and performance, psychology is extremely important in helping us determine what makes an innovation good. It helps us assess and understand an instance of implementation. Specifically, psychology implores us to:

1) Consider the appropriate use of technologies based on student needs.
2) Use cognitive tools to assess learning outcomes.
3) Use diverse research methods to provide more complete and deep analyses of the way the technology is integrated into the pedagogical context

Appropriate use of Technologies

In the introduction to this dissertation, I re-stated a claim that technologies are not inherently good or bad. Rather, it is the pedagogy and personnel that determine the quality and impact of the creation, implementation, and subsequent use. However, there are times when technologies may possess features that make them more or less conducive to learning. At some level, this refers to the way we mediate with technology (Agostino, 1999) and the social relationships we create with technology such as computers (discussed further in point three).

However, I am specifically referring here to the technical design of the innovation in relation to our pedagogical goals and our students' needs. Let us assume, for instance, that our pedagogical innovation is developed to help students learn to spell better. We were going to assess that goal based on pre- and post-tests of spelling. Regardless of the results of the implementation, good performance reminds us to consider whether the outcomes had anything to do with the technology itself. A technology innovation may have appeared to fail, only to discover that the school didn't have enough computers to warrant continuous use by the students. In another case, the technology may have succeeded, but then we discover that the students who showed marked improvement were ones who had hand-eye coordination problems and couldn't

write well enough to make their hand-written spelling tests even legible. They knew their letters, though, and were able to hit the key that corresponded appropriately.

Two students in the "Got Milk?" project, Nancy and Bill, had just this problem. They were considered remedial because of their reading and writing abilities. Danielle told us that these two students would rarely share their ideas. When they were placed in front of a computer and chatrooms set up to discuss milk, however, they excelled. They became leaders according to their teachers, turning in more complete and advanced writing than any of the other students. The confidence of writing well in the technological context gave them encouragement to speak out in class. Does that mean that the innovation (in this case, the chatroom) was and can be useful for helping students learn to write? In reality, we don't have enough evidence (at least as told from this short story of Nancy and Bill) to make that claim. The students may have done just as well merely by sitting in front of a computer, regardless of the innovation. It may have been the medium, not the content, that made the difference.

In either case, this is not a claim about the overall power of the "Got Milk?" project or technology in general. Rather, we discovered that their unwillingness to write was fueled by their poor hand-eye coordination and motor skills in writing. They could not share ideas because their penmanship was bad. Their penmanship was bad because they could not control the pencil well enough to share what they were thinking. Once presented with a different medium of interaction (i.e., a computer keyboard), the students were able to share their

ideas and participate in the class activities.[36] It is likely that this, in turn, prompted their academic growth and cognitive and social gains. Research supports this claim with evidence that computers help students with multiple kinds of disabilities develop literacy skills, specifically in reading and writing (Englert et al., 1998).

In terms of performance, we must conclude that even though we cannot pinpoint the specific features of the Got Milk innovation that triggered the growth, growth did occur. First, we learned (unintentionally) that computers can help some children share ideas, especially those with motor skill difficulties. Second, understanding the first principle allowed us to redesign our study to try to focus our attention on the use of the innovation (software) and not the technology the innovation was 'run' on. In other words, what started as a designed experiment with two groups (software group and control group), turned into one with three groups (software, computer without the specific software, no computer). The point is that without appreciating the technical design of the innovation, we would not have been able to make claims about its use or effectiveness. Good performance suggests that there are characteristics that make certain technologies more or less conducive to learning, teaching, and the creation of electronic teaching and learning environments.

Cognitive Tools to Assess Learning Outcomes

If a teacher or researcher tells you that (s)he developed a successful

[36] Incidentally, that doesn't mean that students should give up on learning penmanship if they have problems. In this case, the teacher realized the goal of penmanship was not associated with the specific assignment she had assigned. In other words, there was a time to work on penmanship; this assignment, however, was designed to have him share his ideas.

innovation, (s)he is probably referring to the fact that it met some aforementioned pedagogical goal as evidenced by a cognitive measure such as a standardized test. This is a significant and important task if researchers are to provide evidence that technology impacts learning. Unfortunately, surveys of major technology and education journals suggest that few technology research studies include student-learning outcomes (Jones & Paolucci, 1998).

There are two important points to consider regarding assessing cognitive outcomes of technology uses. The first relates to having a good innovation. An assumption of my model as it has thus far unfolded (good pedagogy and good people) is that we are trying to get students to understand or learn something besides how to use the technology. Those pedagogical goals in a good innovation are more deeply defined by both the pedagogy and dialogic relationships among the innovator, teacher, and students (due to the flexible nature of teaching and technology); thus, it can be assessed more easily because it is more lucid. In other words, a well-planned project that has pedagogy at its center and people to implement that pedagogy will have more obvious and easily drawn goals *because* on that initial concern for pedagogy and opportunities for legitimate participation. However, technology is so new and exciting to many teachers (and even researchers) that it is often put into the classroom devoid of any content learning goals. (This goes back to the false claim stated in the introduction that technology can just be dropped into a setting and it will magically transform the practices of both the teacher and the student.) It may be possible to measure other outcomes in such a situation, but it is not as

simple to measure cognitive ones. Conversely, implementing an innovation with good pedagogy and good people helps ensure goals that can be measured cognitively.

Having said that, a second related point to consider is that measuring student-learning gains made with technology is a very difficult endeavor (Jones & Paolucci, 1998). Learning, and thus teaching, is flexible. Teachers often implement technology without much preparation or lead-time to match this flexibility in teaching. Even in cases of research studies and experiments, many teachers do not want control groups. They do not want to split their students in half and only give the innovation to certain students. There are ways around this problem, but many have tried to solve it by comparing one classroom with another, making the assumption that they are sufficiently similar (they are in the same grade or the same school) to merit a direct comparison. A more comprehensive approach would be to revisit the integration (of the technology into the curriculum) and plan studies to assess the cognitive and affective impact of those integrations.

The "Got Milk?" project helped Danielle and Elizabeth identify specific student needs, and it provided ways for the students to grow emotionally and socially. Both of those gains then impacted the cognitive growth of the students. Unfortunately, the project happened so quickly, that *strong* claims cannot be made about the cognitive improvements of the students. In other words, the students reading scores improved significantly ($p<.05$), and the teacher reported an overall improvement in grades during and after the innovation. However,

because of the immediateness of the project, there were no control groups; thus, only modest claims can be made based upon the growth we did observe. We cannot rule out the possibility that the students would have made this magnitude of growth without any special intervention.

Measuring cognitive gains is an important task, one that will help us understand more about the ways in which technology impacts learning. In the case of preplanned implementations, researchers can ensure opportunities to measure cognitive growth by verifying the existence of good pedagogy and affordances for good personnel in their design. In the case of just-in-time innovations such as "Got Milk?", researchers need to revisit the integration do learn more about the content, context, and individuals that comprised that innovation. Providing a thick description of the pedagogy, academic content, and roles of the people involved offers the opportunity to undertake this revisit.

Diverse Methods for Deep and More Complete Analyses

Measuring gains in the cognitive domain is a necessary and imperative task for our young field. However, we also need to ensure that the expansion of technology research encompasses questions related to other aspects of students' experiences (i.e., social and emotional). This is an essential component of technology research as affective gains (such as emotional and social growth), as in Sarah's story introducing this dissertation, often precede and drive cognitive gains.

Sarah made cognitive gains in the form of test scores related to reading achievement. The study was based on sound pedagogy and opportunities for

legitimate participation. Furthermore, the research team created control groups to offset the technical functionality of the using the eMate. (In other words, some students followed the same pedagogy without the use of the eMate, and others used the eMate with a different pedagogical approach.) However, it still was not enough to merely describe the cognitive gains made by Sarah; they did not tell the whole story, not even the most important part of the story. Once she started to mediate her relationships with the technology, her self-esteem grew and she felt more like a member in the classroom. That, in turn, afforded more participation in the classroom and more active learning. Saying that the eMate afforded Sarah learning gains is not necessarily false, it is just not completely true. A more complete analysis (as described in the introduction), one that paid attention to Sarah's social and emotional growth, enabled researchers to make more confident claims about the implementation of the eMate. The deeper approach offered insight into new and exciting ways to reach Sarah, how eMates might be used in other classrooms, and how technologies other than the eMate could be used as transitional objects.

Research in the affective domain is not only important as a predecessor to understanding cognitive domains. Sometimes, it is the evidence that helps answer the questions we are asking. An example comes from research on the Next Day Innovation Grants (Zhao, Pugh, Sheldon, & Byers, 2000d). Over one million dollars was given to teachers who applied to do innovative things with technology in their curriculum. The research was designed to understand the successes and failures of those innovations. The results provided evidence that

social interaction (in the form of support or opposition) from others in the teacher's network was a leading factor in predicting success or failure of the innovation implementation (success referred to whether the project implementation met the project's planned goals). [37]

Finally, studying changes such as social and emotive ones are important because research is beginning to provide evidence that humans enter into social relationships with technology. Reeves & Nass (1996) have argued that "individuals' interactions with computers, television, and new media are *fundamentally social and natural*, just like interactions in real life...Everyone expects media to obey a wide range of social and natural rules" (Reeves, B., & Nass, C., 1996; italics original, p. 5). In other words, one starts with any social situation where there are norms and rules, and thus expectations. Replace one of the human actors with a computer actor and the results of the social rule will essentially stay the same. For those unconvinced by their argument, the authors ask whether the person has ever been scared when watching a movie. Other research has backed these claims, providing evidence that humans get angry at computers and even try to act spitefully towards them (Ferdig, 2000a). Documenting this evidence is necessary because successes and failures of technology innovations might be decided on hidden assumptions and expectations that our students place on the technologies they interact with rather than the pedagogy or goals we build into those technologies.

This affective measure, as determined by emotional and social growth of the students, was one of the most salient indicators of success in the "Got Milk?"

[37] Also see: (Pelto & Muller-Wille, 1972; Sharp & Shearman, 1987).

This affective measure, as determined by emotional and social growth of the students, was one of the most salient indicators of success in the "Got Milk?" project. The teachers noted that the "biggest change for the students was internally." They noticed that students were more responsible, would share food, and would tell others not to waste. Students seemed to use the project to express themselves and grow in a way that they needed to. Elizabeth expressed the following about Tyron who was not normally considered a good student:

> I know that many of our students can write and articulate on a way higher level than him in their words. But, he can articulate really well. Like, when we were watching the finished movie and it got to him, he was very bold. It stuck out. When he was speaking, he knew what he was talking about and what he wanted to say. And he did it. I was like, "Wow! Look at him come out in that." If you only had him write it, he wouldn't have expressed that. That wouldn't have come out that strong. Even if you had asked him to make a poster, it wouldn't have come out like that. I saw technology really being key in bringing him out of his shell. It gave him the chance to his knowledge and what he found out. You have another student who spells everything right and always gets perfect scores. She does all her work and gets all A's on her report card. When you watch both of them on the video, he stands out as being a great student. He has a gift when it comes to speaking and sharing, but it doesn't necessarily come out in his writing. I think technology plays a role in helping him express who he is.

Both teachers added that this process built the student's self-esteem, and he was later able to express himself in writing. Danielle specifically noted the improvement in the quantity and quality of the writing he completed during and after the "Got Milk?" project.

A Discussion of Good Performance

Good psychology helps to answer the question of, "Is this innovation good?" By more closely assessing the cognitive and affective (social, emotional

etc.) outcomes of the use of technology, researchers are more adequately able to explain, replicate, and generalize their research findings. This is an important point to consider because good psychology helps us understand two things: a) what gains were made and b) what allowed us to reach those gains.

Does that mean that all three of the points described above (good psychology implores us to consider the appropriate use of technologies, to use cognitive tools to assess learning outcomes, and to use diverse methods to provide more complete and deep analyses) have to be evident in order to have 'good performance'? Not necessarily because not every project will include every type of gain (cognitive, technical, emotional, social, etc.). The idea behind using a deeper psychological approach (and thus a more complete analysis of the instance of implementation) is that performances such as proposed goals can be more easily assessed, and unintended outcomes can be realized, understood, and appreciated. Surely we want to assess whether we met our avowed goals, but we always need to be prepared to evaluate unintended consequences—whether negative or positive (i.e., serendipitous).

In sum, a comprehensive understanding of performance is important because: a) it helps answer research questions about the integration and use of technology; b) it provides evidence as to why cognitive gains were made; and c) it examines the social relationship that we impose on our interaction with technologies. (These, in turn, as argued in chapter one, help to form a more complete and deep understanding of technology use and integration.) Specific evidence presented from the "Got Milk?" project to support these claims included

a discussion of Nancy and Bill's motor control difficulties, assessing the increase in reading scores of the entire class, and the short history of a student named Tyron whose affective growth preceded cognitive gains. However, perhaps the most convincing evidence for the necessity of a deeper psychological perspective on performance (as well as pedagogy and people), comes from the story of Elizabeth, presented in the following chapter.

Chapter 4: Elizabeth's Story

Sarah was an at-risk student who struggled in almost every daily activity at school. When presented with the opportunity to use technology, specifically the eMate, she grew into a leader in the classroom. Data from simple analyses of this innovation, perhaps best called an intervention in this circumstance, demonstrated significant growth in literacy areas such as reading and writing. However, there was more to Sarah's story than just cognitive gains. Sarah's teachers commented on her improved behavior in school as well as her increased social interactions with other teachers and students. Her parents indicated an improved relationship and attitude in her home life.

Rather than attributing all of this growth to the use of a technology, as the teacher initially wanted to do, it was imperative to dig deeper into her story to determine how and why the innovation impacted her life. In doing so, we discovered Sarah using a technological tool as a transitional object. If we are to more fully understand the implementation and use of technology, we need deep explorations of its use as in Sarah's case. At the end of our story of Sarah, we 'know' as much as we can about Sarah and her story, and how to replicate the pedagogy and the roles of the personnel involved in the implementation. We can use data to make claims about the cognitive value of the pedagogical use of the eMate. We can use data to support the impact on the social and emotional life of the child. However, we need to learn to benefit from using psychological tools to understand the relationship between the pedagogy, the personnel, and the student. At that point, we also begin to appreciate the potential of the technology

for cognitive, social, and emotional gains. Compare this approach to the teacher's initial, uninformed, interest in purchasing as many eMates as possible for each and every student.

The same philosophy can be applied to the "Got Milk?" project. The third grade students at Rose Park Elementary learned about history, science, language arts, math, and social studies, as evidenced by standardized tests periodically administered throughout the semester. The teachers and parents also commented on the improved behavior, performance, and attitude of the students at both school and home. The research was not complete enough just to demonstrate evidence of these gains. As in Sarah's case, we needed a thick description to gain a more complete understanding of the innovation.

A thick description of both the pedagogy and personnel highlighted components integral to the learning environment (legitimate participation, flexibility of teaching and learning, authentic problems, etc.). The thick account of the performance of the tool indicated growth and changes in the cognitive, social, and emotional development of the students and teachers (improvement of grades, literacy scores, and attitude). Thus, the account provided a more complete description of what an educator or researcher would need to do to create such an environment (to replicate something like the "Got Milk?" project), and even some possible results.

As "Got Milk?" demonstrated a concern for both the pedagogy and personnel involved in the implementation, can we say that it was a good innovation with any degree of certainty? The cognitive and social results

certainly give us a standard by which to measure progress and growth. However, I would suggest that we dig deeper and use tools from psychology to add to the argument that this was a good performance. Specifically, I draw from narrative psychology and work by McAdams (1996) and others.

McAdams (1996) argues that a person is a history, "a subjectively composed and construed life story that integrates one's past, present and future... A person defines him- or herself by constructing an autobiographical story of the self...the story provides the person with a sense of unity and purpose in life." Thus, by asking my participants to story their life, I intended to learn more about the way in which the use of technology changed, enabled, or re-organized parts of their story.

Instead, I learned that *sometimes participants use their story to change, enable, and organize technology* (see (Miller & Olson, 1994)). At some level, this sounds like the process of dialogic interaction during the implementation of the technology. In other words, a technology can't be dropped into a classroom and magically transform it. Instead, it is a dialogue between the developer and the prior classroom practices of the teacher and students. However, the importance of the story goes beyond the 'prior practices' that have been established in the classroom by the time the innovation is introduced. This history refers to the person's story over the entire life history of that individual.

The most prominent example of this occurring in the "Got Milk?" classroom was Elizabeth's story. She was involved with technology in the classroom, but really only to the extent that Danielle asked her to be.

Technology was used in those cases mainly as a manager of instruction, where Elizabeth would type up forms or letters using the computers in the classroom. Occasionally, she would let the students use them to type a story, but she would not teach with it. However, when the "Got Milk?" and "Conflict Management" [38] projects came along, Elizabeth was very excited for the students to work with the technology. I did not understand why she was using technology the way she was (what role it played in her philosophy) until we both realized (through the course of her story-ing) that she was trying to use technology to *save* the students in her class. She was trying to save them, as you will see, from a fate she felt she almost fell victim to. Elizabeth summarizes her story as follows (see Appendix C for her complete story):

> As a child, I lived and attended school in an urban setting. My siblings and I were at-risk students in both, elementary and secondary school. We were considered at-risk for various reasons. First, our mother ran the household on one low-income as a single parent. Because my mother was a single parent with two jobs, I grew up unsupervised in an unstructured environment. Second, drug abuse was rampant in our family and neighborhood. It was difficult to find a role model in the environment where we lived. In a situation such this, hopelessness characterized my siblings, myself as well as other children in my community. Third, many of the teens my community became parents, dropped out of school and depended on Social Services in order to survive. This appeared to be the pattern passed from one generation to the next.
>
> Another dimension that made children like me at-risk were schools and teachers who lacked hope and belief that students such as myself could break the cycle of defeat and become productive citizens in our community. There were teachers who constantly made negative remarks about our abilities and had low expectations. It appeared that they expected us to fail and behave badly. There were others who judged us by our outer appearance or based on what other teachers said in passing. Finally, the curriculum in our school prepared us to work in jobs that were

[38] The "Conflict Management" unit was Elizabeth's lead teaching project. She adapted the idea of the "Book Club" (Florio-Ruane, Raphael, Glazier, McVee, & Wallace, 1997) to have her students learn conflict management in their own lives.

> working class oriented. College was an option mainly for those who naturally received high grades.

As demonstrated by this short summary, growing up was not easy. She partly attributes being 'saved' to experiences with technologies, granted that the technologies took a different shape when she was growing up. Her favorite memory in her past is when her fourth grade teacher took her class to the local television station. The class recorded a commercial for the station, which was later aired numerous times on local television. Elizabeth reported a deep understanding of the care that the teacher had for all of her students.

> She would always tell me that all students are capable of learning and accomplishing all that they set their minds to accomplish. She always had high expectations for me and never judged me based on my actions or outer appearance. As a matter of fact, she had a way of looking passed negative behavior and seeing the root of a problem. She responded to the root of the problem rather than me. She not only changed my life. She impacted the lives of my children and will have an effect on my children's children.

However, she saw technology, specifically in the form of the television commercial, as a way for the teacher to directly impact the students' lives. Elizabeth noted that although many teachers try to do good for their students, her fourth grade teacher succeeded because of the opportunities with technology. Elizabeth, in turn, identified with almost all of the students in her class and wanted to 'save them like she had been saved.' For her, technology was a way to do that.

> Some of these kids don't see their worth or value. They don't see their importance for being here. If they grow up without seeing that, they won't be productive. I think one of the things that helped me is that I liked to help others. I felt like someone needed me and that made a difference, even if it was superficial. To me, it wasn't. To me, I was able to help someone and that helped me. I think for the students, they feel important

> seeing themselves on that video and CD. They feel important having another classroom come in and learn something from their experience. They felt even more important having a student or teacher from around the world sending them email saying, "We really learned something from this. As a result, we're doing this or not doing this." That was a huge boost, which to me gives hope, purpose, and a reason for being.

I was convinced the "Got Milk?" project was successful because of its performance, as evidenced by the cognitive, social, and emotional growth of the *students* combined with the good pedagogy and personnel behind the implementation. The students made tremendous gains, as did Danielle in her understanding of what a good technology consisted of. However, I could not explain Elizabeth's relationship with the technology. Admittedly, I was initially more interested in the students' learning that I was the pre-service teacher. A deeper psychological approach not only uncovered her growth, but also highlighted the fact that her story dictated her interest or lack of interest in technologies. In other words, she saw the role of technology in her life as "savior." She associated experiences with technology in the past with times where her self-esteem and self-worth grew. Therefore, she assumed (subconsciously perhaps) that the important technologies were ones that would somehow reach out and 'save' at-risk students. Although this lead to important uses of technology, she admitted being blind to other purposes and uses for technology in education. Once she became aware of this, she was able to reflect on how this goal played out in her teaching and teaching with technology. According to Elizabeth, this discovery helped her figure out what the technology was, how she was using it, and what else it could be used for:

One of the things I do know is that I've always had some type of relationship with technology, but it's being transformed right before my eyes—the way I see it, the way I use it, and the importance of it. It's not just a means to an end anymore. So, I'm learning as I go along. I'm thinking more about why I use it than before. Before I just used it and thought, "Oh! This is good because you can let kids see things and do things." Now I'm trying to figure out, is it really good? I'm questioning everything that I think I believe.

Chapter 5: The Impact of "Got Milk?";
Implications for a Deeper Psychology of Technology

I began this discussion by asking, "What do we know about the relationship between technology and education?" It seems like we know a lot, considering both the research available (research articles, journals, books, etc.) and the amount of money (in the form of grants and bonds) that is allocated for technology implementation in our schools.

Yet, the truth of the matter is that we know very little about the young field of educational technology. By now, I am referring to both 'realizing the potential of' and knowledge in the form of strong claims about its use. Evidence to support that assertion has been documented from three different areas: 1) articles, books, journals, and research calling for *more* research to justify the implementation of technology in the schools; 2) calls for *different* approaches to research on technology, specifically that which is more comprehensive; and 3) arguments that abound in the field (and have for some time) regarding the role of technology in education.

One caveat should be noted prior to a discussion of the specific implications of the "Got Milk?" project. In this research project, I studied one classroom over a period of a year. The classroom consisted of 25 students, a teacher, and one student-teacher intern. That classroom and its participants were used as evidence to support the claim of the importance of exploring and understanding a deeper psychology of technology. However, due to the fact that

only one classroom worked with the technology represented in this dissertation, there are limitations on the generalizability of specific claims regarding the integration of the "Got Milk?" technology itself.

The "Got Milk?" Project and the Three P's

Perhaps an answer to the initial question is that we know, or at least are beginning to know, more about what makes a good innovation. This is an important question for our field because it helps establish and reiterate what we know, which in turn sheds light on what we still need to learn.

In this research, I studied a technology innovation called the "Got Milk?" project. Through analyses of individual behavior and social interactions as well as an extended literature review, I developed a model entitled the "Three P's." The P's refer to the elements that make up a good technology innovation: pedagogy, people, and performance. Pedagogy sets the stage by analyzing technology as a product (although from a social constructivist perspective, arguably it can be seen as a process as well). The product, that being computer hardware and software implemented into the curriculum as well as the artifacts created in its use, has components requisite to learning. Specifically from a social constructivist perspective, technology innovations must provide opportunities for learners to: a) engage in authentic and challenging content (at the high end of the learner's Zone of Proximal Development); b) actively participate, including collaboration and social interaction; c) develop a sense of ownership; d) create artifacts in a variety of ways; and e) publish, reflect, and receive feedback.

The second "P" that makes up a good innovation is 'good people.' Where pedagogy focused our attention on the innovation as software or hardware (i.e., product), 'good people' shifts interest to technology innovation as a process. This process highlights the fact that innovation implementation necessitates having people who understand the relationships that exist between the different members of the innovation. Legitimate peripheral participation, essential for the development of mastery level skills and the growth of identity in a community of learners, can be achieved when developers: a) understand the dialogic nature of innovation implementation; b) engage in genuine interaction with teachers and students; c) appreciate the flexible nature of teaching; and d) help teachers understand the flexible nature of technology.

The final element of a good technology innovation is good performance. Psychology helps us answer the question of whether or not an innovation is good, where good refers to successful. Good psychology defines success as a deeper and more adequate understanding of the technical, cognitive, and affective gains made through psychology. This requisite helps us understand and assess an instance of implementation so that we can better describe, replicate, make claims about our technology use.

Good pedagogy, good people, and good performance are described as the three main components of a good innovation. Are all three necessary, though? There are times when well-designed software helps someone teach because of the built-in pedagogy steeped into the design of the tool. There are other times when a knowledgeable person can take a technology and make it

pedagogically sound 'on the fly.' In both cases, one drives the other. We can support teachers with pedagogically sound technology; and we can learn from teachers who make technology pedagogically sound. Therefore, yes, the first two are definitely required, but they tend to be responsible to one another. One will always require the other; good pedagogy is part of a process and the process includes teaching with good pedagogy.

The last point, good performance, is the one we know the least about. We do know that it is imperative to include in order to better understand the role of technology and education; this explains the number of calls to justify the expansion of technology in our schools. However, along with more research to justify implementation, we need different methodologies to understand what that assessment looks like. For one project, that might mean coming to a deeper awareness of how the technology impacted the learning. In the cases of both Sarah and Elizabeth, using psychology to examine performance entailed not stopping at cognitive gains (school test scores or more knowledge of technology) but more deeply exploring why those gains were possible. In each case, it means a more comprehensive approach to measuring intended as well as unintended goals.

Implications of Elizabeth's Story and the Three "P's"

Studying the "Got Milk?" project provided the opportunity to understand what makes a good technology innovation. Described below are implications of this study and future research that needs to be completed on this important topic.

Teaching and Development. Good technology innovations are those that are imbued with strong pedagogy and opportunities for growth in the learning community. Teachers and developers must learn to appreciate the flexibility of teaching, as well as the ways in which the flexibility of technology can reciprocally support the initial pedagogy and instruction. These understandings are supported by the design of innovations that are adaptable (as set-forth by the idea of component-based architectures) and part of a dialogic interaction that promotes mutual growth, change, and advancement of the technology and the corresponding pedagogical goals.

Research. The field of educational technology has made important advancements regarding understanding the pedagogy and people behind technology innovations. As evidenced by the research discussed and presented here, active participation in authentic tasks using technology, along with people who understand how to legitimately bring people into the learning community, afford greater opportunities for gains in multiple domains. However, like many others, I highlight the call for more research related to understanding these technology innovations. We do not have the evidence we need to justify the expansion of technology in the schools.

Most importantly, in establishing this research agenda, we must aim for a deeper, more comprehensive psychology of technology. A deeper psychology invites questions regarding cognitive gains as well as affective, social, and emotional ones. There are intended and oftentimes unintended consequences of using technology. More methodologies are required explore and appreciate

these unintended outcomes. The narrative methodology used in this dissertation may prove beneficial to that call.

Teacher Education. Using an approach from narrative psychology, Elizabeth and I discovered that her story was guiding her decisions about why, where, and when she wanted to use technology. Perhaps even more importantly, however, was that *Elizabeth seemed to be using the narrative methodology as a way to make sense of why she went into teaching, what she was learning about teaching, and how to integrate teaching with technology.* Many of our conversations were spent talking about previous or future lessons and what happened during the day. Successes and failures were re-lived through the telling of the story as if part of the time were natural storytelling and story-construction opportunities. Swidler argues that narrators create hostile worlds and simultaneously recreate themselves as heroes in those worlds (Swidler, 1999). Although arguably not hostile, Elizabeth was learning to make sense of the new 'world' and her place in that world.

In other words, once she had storied her experience, she was ready to plan what kind of teacher she wanted to be and how she was going to use technology in that role. George Howard (Howard, 1996) calls this process 'teliography.' It refers to understanding the causality that we have in our stories. If an autobiography tells a story of the past, a teliography tells a story of the future. It gives us a guide to set our sights on.

> Metaphorically, a teliography is like a climber's grappling hook. The hook is thrown to a point higher on the mountain that the climber hopes to scale. Once secured on some distant point, the grappling hook serves as

> an anchor that the climber uses to close the distance on her or his desired goal. (p. 132)

Using her story to better understand where she had come from, Elizabeth created stories about where she wanted to go. She developed teliographies [39] of her life, her teaching, and most notably for this conversation, the ways in which she hoped to implement technology in her future classroom.

> Reflecting on my story has helped me think more about my teaching philosophy. The teachers who affected my life affected the lives of my future students. I'm making a difference because of them. It's so powerful to see how what one person does impacts others. I believe as a teacher, even if you can impact just one child, it will make a difference in multiple lives. It's letting them know that you accept them because they're a person with a heart, a hope, and a future. Therefore, one part for my teaching will be to aid in their construction of knowledge; the other part will be to show these kids that we care unconditionally...Moreover, I want my students to work with multiple kinds of technologies. I want them to use video cameras to create and record scripts and plays that someone else could watch and be inspired by. I want them to use the Internet to do research. They could create a project and then find out whether someone has done this already and what types of ideas they had. Wouldn't it be neat if they could find something on the Internet that's led by students, their own peers?

For Elizabeth, this narrative approach, initially serving as a research methodology, enabled her to learn more about who she was as a person and as a teacher. By creating a history of her life, she provided a base in which to reflect on her teaching as well as climb towards higher places and more advanced goals (Blumenfeld et al., 1994; Howard, 1996). Those teliographies described who she wanted to be in the future, specifically in relation to her

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[39] A person can have more than one teliography depending on the context in which you are using the term. At a very local, specific level, I may have a future, fictional autobiography—a teliography—about the type of scholar I wish to become. Or, I could have a teliography about how I one day wish to use technology in the classroom. At a broader, more general level, arguably all of the teliographies could fit into a 'meta-teliography' of the person I want to be. In this specific case, Elizabeth's teliographies included topics such as teaching, teaching specific subject matter, and teaching with technology.

teaching. Others have highlighted this finding about the importance of using autobiography, specifically as a way to help teachers learn more about their culture, their pedagogy, and their students (Bruner, 1996; Florio-Ruane et al., 1997; McAdams, 1996; Nicolopoulou, 1996; Wannar, 1994).

More recently, it has been suggested that narrative approaches provide an important vehicle for teachers to learn about technology (Ferdig, 1998; Harlow & Johnson, 1998; Miller & Olson, 1994). In this study, a teacher used a narrative approach to understand where technology fit into her story. She began our time together talking about technology as a way to make what a teacher did more efficient; at its best, it was merely a motivation tool for students who were bored with the traditional classroom. At the end of our time together, she shared her philosophy of teaching with technology, a philosophy that described technology as being able to transform her teaching and her students learning (see Appendix B for her complete philosophy).

Cognition and Personality Theories. I made claims in this chapter about Elizabeth's growth and her teliography, drawing on work by George Howard (Howard, 1996). I also suggested in the introduction to this dissertation that the way to 'know' this teliography (or teliographies) was to get to 'know the person' using the narrative framework of Dan McAdams (McAdams, 1996). Finally, I cited work from Lave and Wenger (Lave & Wenger, 1991) and Vygotsky (Vygotsky, 1978) in chapter one to suggest that the importance of getting to know a person and their teliography was not only to demonstrate growth, but also to

help them develop their identity as a master practitioner in a community of practice—thus highlighting Vygotsky's notion of learning as social in nature. [40]

In one sense, there seems to be an implied competition between the aforementioned narrative and personality theories of McAdams and Howard and the learning theories presented by Vygotsky, Lave, and Wenger. McAdams and Howard suggest the importance of the development of the individuals' story (autobiography and teliography). The development of identity is seen as the creation of individual teliographies. Vygotsky, Lave, and Wenger, on the other hand, emphasize the importance of learning as a social action and one that requires emergence into a community of practice. [41] Identity development from this perspective entails becoming a member, and specifically an active member, in that community of practice.

Combining these approaches solved problems I experienced in planning an exploration of individuals' learning about technology. From a social constructivist perspective (i.e., learning theories of Vygotsky, and Lave & Wenger), I knew that the learners in the "Got Milk?" project were entering into a community of learners. The students were learning to use tools (i.e., video cameras, tape recorders, and computers) that experts in the community used to solve problems. Moreover, they were engaged in knowledge-building exercises surrounding important artifacts in the learning community (i.e., knowledge in mathematics, science, history, etc.). The teachers were also learning. Danielle was learning to use technology in her teaching, while Elizabeth was learning to

[40] The methodology of Geertz (Geertz, 1973a) was used to capture this social interaction.
[41] This is also discussed in work cited on the Vygotsky Space (Gavelek & Raphael, 1996; Harré, 1984; Harré et al., 1985) in chapter one.

become a teacher (and a teacher using technology). Using Geertz (Geertz, 1973a) to examine these interactions and development into a learning community was a necessary but not sufficient way to explore a deeper psychology of technology. If I had used Geertz's methodology without an exploration of the individual, I would have potentially subscribed to the notion that we are nothing more than a product of our social interactions. To re-examine the Vygotsky Space discussed in chapter one, important components of the social sphere are publication and conventionalization. However, the individual is also involved in the processes of transformation and appropriation (Gavelek & Raphael, 1996). Where Geertz provided a lens to examine the social nature of the learning community, McAdams and Howard afforded an examination of the individual as an actor in that social world.

Conversely, to only use McAdams and Howard would not only ignore important social components of learning (i.e., a more knowledgeable other in the Zone of Proximal Development), it would leave open the possibility that a person's teliography could be as open-ended as possible. In other words, understanding personality from a narrative approach, according to McAdams and Howard, revolves around getting to know and further developing an individual's story. However, realizing that a person's story is part of a larger society—a community of practice—helps ground the story. For instance, Elizabeth wanted to become a good teacher. She could have decided that being a good teacher meant not ever letting your students talk. Working with colleagues, professors, and her coordinating teacher (Danielle) provided resources to publish and

receive feedback on her story and teliography of what it meant to be a teacher. This is not to suggest that her story had to follow and could not change others' stories. In one example, Elizabeth suggested the use of a CD-ROM (something Danielle and I had not considered) to supplement student creation of artifacts. Her teliography about what a classroom project should look like did not match our stories, but helped us grow with her. The point is that in order to create a deeper psychology of technology, I needed these individual approaches to personality to better describe the occurrences of learning in a social environment. Equally, I need social theories of learning to explore the ways in which an individual was developing (including the adaptation and growth of their teliographies).

I am not suggesting that this dissertation completely bridged and solved the differences between social learning and individual development. However, I propose a deeper psychology of technology is and was a way, in some sense, to draw on the benefits of both of these approaches, albeit both having different premises and intentions. For instance, rather than being seen as merely the entrance into a community of practice or the development of a story, identity could be defined as the development, publication, and revision of the story of a member *within* a community of practice. This seems to be the heart of using a deeper psychology of technology: the willingness to exploit the benefits of multiple psychologies (i.e., psychology of learning, psychology of personality, etc.) to more deeply and completely understand phenomena such as the integration and implementation of technology.

Summary and A Call for Future Research

In sum, the three "P's" serves as a model to help us understand what we know as well as what we still need to learn. We know that technology innovations that adopt a deep psychological approach for assessment and evaluation lend themselves to a more multi-layered and complete understanding of the impact of the technology on the people and pedagogy involved in the innovation. In continuing to explore both the existing and potential relationships between technology and education, we must make sure our investigations of explorations have a depth and breadth to them. This depth and breadth refers to a more comprehensive approach, as afforded by psychology, one that provides opportunities to create, implement, and study technology in pedagogy. In that approach, a narrative methodology deserves more consideration, especially as a way of teaching teachers about how technology fits into their story.

The research on Sarah's use of the eMate and efforts to understand the "Got Milk?" project have both added to the repertoire of tools that we have as psychologists and educators to understand the role that technology does and can play in our schools. Specifically, these studies document using technology as a transitional object and the efficacy of a narrative methodology in helping us understand the use or lack of use of technology. Future research needs to continue to broaden the relatively new field of educational technology. We do not have the accounts we need of the emotional and social responses of students to new educational technologies. We need to know more about the importance of joining multiple psychologies to understand technology integration. The task of

technology-focused, educational psychologists and teachers, then, is not only to establish more structured research and teaching agendas, but also to expand the diversity within those inquiries.

Appendix A: Interview Protocol

Adapted from "The Stories We Live By" (McAdams, 1993)

1. Think about your life as a book. Each part of your life composes a chapter of that book. Divide your life into as many chapters as you would like (you can give me a table of contents if that's easier), and tell me about the role of technology within each of those chapters. You don't have to tell me each and every story for each chapter. Instead, try to focus on the main points and think of this as the story's outline.

2. Describe as best as you can, eight key events relating to technology in your life. Those events are:

    a) best experience with technology
    b) worst experience with technology
    c) turning point in your technology use
    d) earliest memory of technology use
    e) important use of technology by someone else in your learning/education
    f) important use of technology by yourself in teaching someone else
    g) an experience with someone who looks up to you for technology help
    h) an experience with someone you look up to for technology help

3. Describe the four most important people in your development as a technology user.

4. As you continue learning and using technology, what is next for you? What is your overall plan, outline, or dream for the future in learning to use technology?

5. Please describe two areas in your life that represent a major stress or conflict regarding technology use.

6. Looking back at the history of technology use in your life, can you describe a central theme, trend, or idea that runs throughout that text or those chapters?

Appendix B: Elizabeth's Philosophy on Teaching with Technology

I had some time to think about what I know to be true about technology and how it can transform teaching as well as allow students to do things that they would not otherwise do. After deep reflection, I have come to realize that I am barely skimming the surface. However, I am very interested I learning how technology enhances learning especially for at-risk students. I am very interested in how technology can be used to transform teaching. I want to learn and understand better how to effectively integrate technology in classroom learning. I noticed that the state technology standards emphasize that the students' outcome should be critical thinking, self-directed learning, creator producer, and effective communicator. I feel like a lot of what I am learning will prepare me to continue to pursue ways to responsibly integrate technology and the curriculum.

How can technology transform my teaching?

- Efficiency, I am able to quickly get information from the Internet for class lessons, presentations, and papers. I am able to keep an accurate log of my students' progress and . I am able to create and store lesson plans that I would other wise have to maintain by paper. It is definitely easier for me edit and make changes to a unit or lesson plan if needed. Finally, I am able to use the computers to communicate with my professors, field instructor, collaborating teacher and other interns to give and receive feedback that helps me to shape, improve create, or complete lessons.

- I use web sites that are children friendly introduce new ideas and current events. These sites have been good attention grabbers that the students later used as research.

- I use it as a research tool. I have access to thousands of ideas and research that I would not otherwise have. These web sites would give me unit ideas, what works what does not work, access to lesson plans, cutting edge research by other educators as well as cutting edge programs such as TELE, etc that enhances students learning. I believe that access to such information would make a huge difference in the way that I plan and the content that I teach. I think that communication with other educators as well as collaboration is key to the growing process of teaching and development of unit plans. Without technology, it would be very difficult to have access to all of the resources that are available. Technology puts these things at your fingertips. It is difficult to try new things that research has to offer if you do not have access to it. Also, your teaching can be transformed by becoming a researcher as well. Your class can become a source for research that you can use to test the ideas that are presented from different sources. One example is the research that I am

participating in with Cheryl Rosaen and James Damico. They are documenting the teachers working toward standard-based elementary level classroom practices. Mary Lou and my contributions focuses on the way that interns plan and teach Literacy and Language Arts. They are recording this unit being taught along with interview questions. They are using the reflections that I write after every lesson as well as feedback that I get from Mary Lou. In the Language arts subject area, materials are developed that highlight a different cross cutting theme such as: assessment, teacher knowledge, planning, decision making while teaching, designing lessons and units that engage children investigating big ideas/questions, classroom learning community, strategies for reversing gender/race obstacles, appropriating the discourses and practices of the discipline. This research will be web-based. Although it is secure, educators will have access to it from different locations. These materials will be explored by other teachers candidates, teacher educators, and classroom teachers in a variety of text.

- Imagine the teacher who uses the very traditional approach i.e. Do not use: collaboration, cooperative learning, technology, ideas presented from new research. Imagine the novice teacher. I would say that the above items would transform their teaching. It has for me in many ways. I have use the research of others and I have access to items such as ERIC that give cutting edge or recent research. Research enables me to learn new approaches, techniques. It helps me to understand new developments in the learning process as well as in the field. These things influence what and how I teach.

- The use of technology provides many options for teaching, teachers who use it (not just computers) have less limitations than for those who do not use it.

- Collaboration with lesson planning and discussion that would otherwise be difficult to do due to distance and time.

- When I began to plan to teach using one of the book club instructional models, I did not know a lot about book club. I knew that one of the person who's model I was using was a professor at MSU. I attempted to look up her e-mail address to ask some questions that would help me to better understand how book club might work for third graders since her book focused on fifth graders. E-mail at that time was the only way that I could communicate with her.

What will technology allow my students to do or learn that they would not be able to do otherwise?

- The students become inquiry based researchers. They have access to as tons of information and multiple perspectives. Because of this they can use judgment, decision-making and critical thinking that is high order. Current events are readily available to them. They can make immediate connection from what is learned in the classroom to various electronic sources. They can produce and share ideas around they would.

- They can learn about other communities worldwide and compare and contrast cultural differences first hand by speaking to other children in different communities.

- They can see first hand and interact with different students all over the world.

- They can capture teachable moments and share them with others (distribution would not be a challenge.

- They can create and publish to a broader audience.

- They have access to work created and published by their peers that enables them to make comments to and received comments from a larger audience.

- Students like Arron can continue to learn and use several processes such as analytical and critical thinking that would otherwise be impeded without the use of technology. He could do both take part in the learning process and at the same time work to increase his hand coordination motor skills by practicing writing when the emphasis is on writing and not on using the other processes mentioned above.

- By giving students access to technology, they learn to use it responsibly and become comfortable with using different items such as computers, cameras, video cameras etc. They become computer literate and learn early how to use it to enhance their own learning. They won't be afraid to learn new things that include use of technology.

- Technology can help students who can't write to create meaningful stories and listen to them for enjoyment, editing purposes etc.

- Students can work together with a larger audience to solve a problem or answer a inquiry question.

Appendix C: Elizabeth's Story

"Do you think I'm bothered by that?"*or* "I will survive": Elizabeth on growing up and staying alive

I began a research project in a local school, because I was interested in examining the components of a good technology innovation. Although I could use certain measures to assess cognitive improvement (i.e., test scores), I chose to borrow an interview protocol from Dan McAdams (McAdams, 1995; McAdams, 1996) to explore the story of the individual. The hope was that this story-ing process would allow me to more closely examine how a person learned to work with technology, as well as discovering and uncovering other gains made through the interaction with the technology (social, emotional, affective, etc.).

Although the story-ing was meant more as a research methodology, the process fundamentally changed the way Elizabeth though about herself, her teaching, and technology. This unintended consequence has important implications for instructing teacher educators and for teaching technology—implications that will be discussed in the final chapter. However, Elizabeth's text (my summary of the co-constructed dance and dialogic interaction we experienced over the weeks of the research project) is included below because of the power of her story.

* * *

I normally don't share my story. As a matter of fact, I have not shared the complete story until now. It's much too painful for me. Two years ago, or even last year, I would have cried this story rather than told it. However, I am starting to forgive, and with forgiveness comes healing. Healing is strange, though. On one hand, you want to let go of all the things that hurt you so bad, but on the other hand you still want to be angry. Then, you realize being mad is hurting you more than anyone, and so you lie and tell yourself you're not mad. It's there, though. It's hidden down far enough that you don't really see it. But, it's there.

I tell my story because it helps remind me of who I am and why I am here. Here means alive, surprisingly, at age 28. Here means trying to become a good teacher. Sharing, and thus putting the pain into words, helps me realize where and who I am. I tell my story because I want to encourage people to overcome things and be who they want to be. I have been through so much, I shouldn't have my right mind, but surprisingly I do. They can overcome, too.

I wish I knew a good way to share this story with my students—especially my 'troubled' students. I want my life to be an inspiration for them. I want them to hear my story and say, "There is a way out if I keep trying." Most students think you can't relate. They see us dressing nice, driving nice cars, and getting

what we need *and* what we want. It's hard for those students to believe us when we say, "I understand." I do understand because I've been through it. There were times when I didn't know if my parents were going to come home or when food was going to be on the table. When you can show that part of you, students can see where you've been and where you are now.

For now, I give them more of a look. When they're telling their story, I give them a look that says, "I know. I've been there. Here's what I can do, here's what you can do...I wish I could do more. I won't feel sorry for you, though; we are not victims. I'm not bothered by those 'things' and neither should you be."

* * *

I was born in Lake City in 1971. I grew up in a family of four with one older sister, a younger brother, and a younger sister. My father left us when I was five, so we were very poor. I was very angry when my father left because he was my best friend—we used to do everything together. (Although they were not always good times. My earliest memory is of playing with his lighter. He had this silver lighter with a lid you could flip open. I used to like playing with it. One time, he let it get really, really hot so when I grabbed it, it burned my hand and I didn't touch it anymore.) After my father left, many of my extended family members grew to hate me. They told me I would never amount to anything good. I'm sure they told me that because I closely resemble him in looks and personality.

I remember the day he left. He had become influenced by the actions of my cousins and started drinking uncontrollably. It got so bad that he started to mentally abuse my mom. One day, he physically abused her, and she never came back home. She told him to take us to my grandmother's house but she wouldn't come home. He begged her to come back, but she wouldn't. Part of not being willing to return was fear. He told her that if she ever left him, he would kill her. And, if his anger were anything like mine used to be, he probably would have. The other reasons included rumors of his infidelity with other family members.

* * *

My mom returned the day my father moved away, and she raised us as a single parent. She had dropped out of school in the 7th or 8th grade (she later returned to get her GED) and so we were always moving to where she could find work. Throughout these moves, school was so important and fascinating to me. I remember growing up seeing school as a way to survive. There were many times when I had to walk miles to get there. When we moved, I walked to the old school until either I was able to change schools or school got out. In the 5th grade, for instance, we lived about two miles away from school. We were in a not-so-good neighborhood, so I really don't know how I made it. I probably made it for the same reason school was important to me—I had teachers in every level of schooling that made a difference in my life.

In elementary school, it was my fourth grade teacher. She was actually one of the only people who I ever remember implementing technology into the classroom. The local television station was producing a commercial advertising their news. She arranged for us to go to the station and meet the people, see the equipment, and practice and record a new song for their commercial. It wasn't technology like today's computers, but it was television and reporting. It really made a difference in my life because I felt important. I thought, "Wow! She really cares. She is going beyond math, English, spelling, etc." I think a lot of times kids are just looking for just person to show that they care no matter what (unconditionally). I was no exception and having my teacher take us to this place made me realize she cared.

In middle school, it was my civics teacher and my homeroom teacher (who incidentally died in a car accident before I got out of middle school). It seemed like she didn't care if she hurt your feelings, but she just gave you the hard facts. She didn't try to make you feel good, she just wanted to help you see who you really were. It wasn't easy, but it was something kids at that level needed—a good shot of reality. If they're in a fantasy world, and they don't see who they are, what they need, or who they want to become, they're going to be in a world of hurt come high school and college.

* * *

Both of those teachers influenced my life so much that I see parts of their teaching philosophies in mine. However, perhaps the most influential person was my teacher in high school. When I was in high school, I didn't have the kind of parental support and guidance that I needed. My mom was a good friend growing up who cared about us deeply. And, considering everything she had been through, she was the best mother that she could be. She had her first child when she was fourteen. She had her second when she fifteen. She eventually got married to my father when she was sixteen just to get away from the abuse she experienced at home. So, to suffer the abuse in her own house was just too much for her to take. She didn't have the outlets that I had. She didn't trust anyone including herself. She had so much on her chest and didn't have the outlets that I did. All of the hurts and disappointments caught up with her and she started using drugs. My father was long gone, and everyone else in my family was addicted to something (crack, cocaine, alcohol...whatever!). They were always high, while I was just trying to survive (as I'm sure they were; we just had different ways of doing it).

I was still working at this time and had been since I was about twelve. I had to. There were times when my mother would just disappear. We were left with no food and no money. By this time, my oldest sister couldn't stand living at home anymore; so, it was just me (age fourteen), my little brother, and my newborn sister. (When my mom got pregnant with my youngest sister, I knew I was going to be her built in babysitter). When my little sister turned one year old, my mom and her boyfriend moved into an apartment together. Her and her boyfriend would come and visit us every once in a while (I was about fourteen). I

was the head of the house while I was trying to be a kid. Luckily for me, the market down the street had day-old food that I could buy (and hope that it wasn't bad).

Needless to say, I was exhausted, scared, confused, and abandoned. However, I didn't dare tell anyone. I was afraid, like I'm sure most kids are, that if I told someone my situation, they would split all of us up into different homes. As a kid, I didn't think that was a good thing. That's when I met my high school English and drama teacher. When I first met Ms. C., I was afraid to go into the classroom. It was my first day of ninth grade. She came around the corner and I thought she was so pretty. She said, "are you afraid to come in here?" I told her that I couldn't come in because there were too many people in the classroom. She said, "I'm afraid, too. Today is my first day teaching." I thought, "Wow! She's afraid, and I'm afraid. We'll go in together and we'll be ok." I ended up having her for drama all through high school. It wasn't that I liked drama that much; I just wanted to have her for a teacher. (I ended up loving drama as she got us more and more involved in theatre outside of school.)

Ms. C. got involved in my life beyond just the classroom. She picked me up and took me shopping. She talked to me about things. She got me out of the house. She taught me how to be responsible. I remember one time a boy offered me a donut. He offered me one donut, and I took the whole bag. I would beat up kids as quickly as I would be their friend, so taking the bag was no problem. Ms. C. came up and showed me how I was wrong. (Little did she know, of course, that I didn't have food at home.) She was just trying to teach me about being a lady.

I know one of the reasons I liked Ms. C. so much is that I needed someone in high school and she was there for me. I needed so much attention and she gave it to me. I had really low self-esteem and was mad at the world. I felt like if my father could just leave and never come back and my mother leave me and live with someone else, something must have been wrong with me. No one wanted to be around me. So, I grew up thinking something was wrong with me. This teacher showed me in so many ways that this wasn't the case. Without probably even knowing what she was doing, my high school teacher stepped in at a critical time and it made a difference. I cry when I think of how much she meant to me. It's important for me to reflect on that, though, because it reminds me all over again why I am here.

* * *

In high school, things only got worse for me. I was still a pretty good student considering all that was happening at home. (Incidentally, that's one of the reasons I can't handle students saying they're bad because of what's going on at home. I want to tell them that I've been there and done that, and still never talked to my teacher that way. But, I suppose times have changed. There are different things on TV. There are other things that probably didn't exist when I was younger.) Because of my grades, I received basketball and academic scholarships to attend a school in Tennessee. Although I wasn't sure what I

wanted to study, I knew that I had to go to school to have a chance. Unfortunately, I didn't have anyone to take care of my younger brother and sister. I was going to try to take them with me, but the school in Tennessee wouldn't allow it at the time. I had to turn down those offers.

I also met a nice guy in high school who became my best friend and later my boyfriend. I met him because I babysat for his aunt's children. We were so close and he helped me through so many of my struggles. A month before prom, he was killed in a car accident. I became so nervous and stressed, that my nose would bleed profusely ever day around third period. I went to the doctor, and they wondered how I was walking. They told me I shouldn't be alive because of my blood count.

Things finally hit rock bottom when my mother moved back into the house. She would steal our food money to get high. One day I came home and saw my mom and older sister getting high. They looked so bad; they looked like they had skins over skeleton. I watched my mom and sister go from being very smart, beautiful women to look like dead women walking. I lost it. I had a nervous breakdown. It was one thing to know they did it. It was another thing to walk in and see them using it. When I was able to relate to people again, I went to live with my boyfriend's aunt. I didn't want to leave my mom because I didn't think she was going to make it. But, I couldn't take it any longer. I couldn't stand the environment and I knew I wouldn't survive. If you're in an environment where everything is negative and you have no support, it seems like there is little hope. This is one of the reasons why I think teachers are important.

I did graduate, and continued to visit home to check in on my brother and sister. I decided to take them to foster care the day I came home and found no one there but them. My mother and older sister had gotten high and left them to fend for themselves. I couldn't take it anymore, but I couldn't take the burden (physically, emotionally, mentally, or financially) of caring for two other people. I could barely care for myself. Friends of mine who were foster parents agreed to take them in and became guardians of my younger siblings.

* * *

With parts of my family gone and the rest in better hands, I decided to attend Lake City Community College with the help of all kinds of loans and grants. I tried to focus on being a student but couldn't because of all the issues I was dealing with. I was getting B's and C's but not applying myself to anything. I just knew I had to be there.

I did my first year at Lake City CC and then had the summer off. Everywhere I looked, I saw people being killed, adults and children using drugs, people going to jail, and girlfriends murdered because of who their boyfriends were. I needed to escape. I was watching TV and saw the Air Force ad stating that they would pay for some of your college. I got in my car, drove to the recruiter, and told him that I wanted to join that day. A month later I was gone.

I had it planned perfectly. I was going to be in the Air Force during the summer and on weekends, and would go to school during the academic year. I

returned from the military at the end of the summer refreshed and convinced that life was finally going to start going my way.

* * *

When I returned from the military, I went back to live with my boyfriend's aunt. While I was gone, due to the influence of her boyfriend, she started using drugs. I was afraid of the drug use and physical abuse in their relationship, but her boyfriend actually made me feel safe. One time, he almost killed a guy who showed up at the house to take advantage of me. He dragged the guy down the street and was going to shoot him. I begged him not to do it, as I didn't want his life ruined.

He also treated me very nice. He was kind and bought all sorts of things for me. Little did I know that he had his eye on me the whole time. It was almost a mental rape before a physical one. I was thinking that the guy was looking out for me. Instead he was just setting me up. It's hard to put into words, but the feeling is of ultimate betrayal. I woke up one night and he was in my bed on top of me. I told him that if he didn't leave I was going to scream. He left that time (and I should have as well), but he created a little scheme and sent his girlfriend away for the weekend.

For a long time after that, I thought it was my fault. I was only a child and this man knew what he was doing. But, I felt loyal to the aunt because of what she had saved me from. I also knew that if I told her, she would have blamed me. She would have told me that it happened because I wanted it to. It's a hard thing to live with—someone taking something from you that you don't want to give, but afraid if you don't you'll get really hurt. That's a very scary thing

* * *

At that point in my life, I started visiting churches. I needed something. The 'aunt' was still doing drugs, but had to do them in my room because she didn't want her boyfriend to know. I would come home and the same smell I had left (my mom's home) was the same one I was going to. The boyfriend was following me to work and continued to try to force himself on me. He kept telling me that I belonged to him and could never be with anyone else. I needed peace so badly but I could not find it. I knew that if I stayed where I was (physically and mentally), I was going to perish. Not as in 'going to die', although that was a possibility. I was going to miss something—probably destiny.

I went to church one day and told them that I wanted to know Christ. They took me in a room and made me say all these things and baptized me. I went home feeling worse and out of place. I still didn't have a relationship with Christ, but I was told that I was 'born-again' because of the words I had said. So, I asked Him for a roommate because I couldn't afford to live all by myself. I asked for a roommate that didn't use drugs, didn't have a boyfriend that sold or used drugs, and was trustworthy. I wanted a friend to stay with that I could go to bed

at night and feel safe. I wanted to know I could sleep without having things stolen from me.

That's when I found my friend and my children's Godmother. We clicked right away, and I moved in with her. The only problem was that she had a standard of and for living and I didn't. I was still doing things that a good person doesn't do. Once I moved in those things began to become a problem. When she asked if I was born-again, I said, "Yes!" I had said the words but my life hadn't changed. I was still living the life that I had come from. She continually asked me to go with her to church. I said I would, but I never did. I guess I felt like I knew I needed something, but church didn't do it for me. I had tried that and it failed. I was thinking the same thing would happen. I didn't want to go all the way to where the church was in Hartford; I knew that if I did, it would be the same thing as before.

* * *

My pain continued, as did my attempts to find peace. One night at New Year's Eve, I went to a Mason's party. I was feeling lonely and just needed someone to care and someone to listen. I went to their party and drank everything in sight. The next day I was so sick. I have never felt so terrible in my entire life. I thought, "I will never drink again."

That morning, I was in my room and feeling awful when I felt this compelling need to go into my living room. When I got there, I just fell on my knees and prayed. I talked to God like I had never talked to him before. I knew He wanted to talk to me. There was this urge to get down on my face and pray. I wasn't a church person, so I didn't know the rhetoric or the things people do in church. I told him that I really needed Him to guide me, and I opened my life up to him. It was weird because I felt like even though I was the one doing it, I wasn't in control. I knew God was there. My roommate came home from church, and I told her what had happened. She was elated because she had been praying for me all year long.

Guys were still calling me, but I had really changed. One friend, an intimate friend from the past, called and wanted to get together. I told him I couldn't see him again, that I had given my life over to Christ. I was talking about God to everyone (some of them consequently stopped talking to me!). I was experiencing this peace that I had never felt before. I had tried all of these different things and couldn't find peace with myself. When I was talking to God that day, I asked him for it. The pain that was always there was gone. It wasn't gone forever, of course, as you always have to deal with what's causing the pain. However, I knew that even with that pain, I was going to be ok. I was going to make it. I was not going to perish. That's when I started coming to church in Hartford.

* * *

Although things were beginning to get better, I was still living in Lake City. I realized that I would feel good leaving church in Hartford and then feel awful during the week in Lake City. There's a whole different spirit in that city. I can't explain it, but I know it when I cross into the city line. I called my pastor (who was my roommate's father), and said, "I get this feeling that I'm not going to survive if I stay here." He was amazed, because the same time I called him, he was calling me to tell me that he and his wife wanted to invite me to come stay with them. They, too, were called to believe I wouldn't make it if I stayed.

Everyone thought I was on drugs I was out of there so fast. I gave my roommate her share of the rent, gave my job a one week notice, etc. I knew that I couldn't make excuses for leaving or I would never go. I couldn't even think about it. If you think about something long enough you can talk yourself out of it. I was going to stay in my pastor's house for a couple days, and I didn't leave until I got married. They saw my desperation. I got so much nurturing that my life changed drastically. If you had known me back in 1990, you wouldn't have been able to sit in the room with me. I was a nice person, but I was so unhappy with myself that it came out. My whole outlook changed because of the relationship I had with my pastor and his wife.

I never had a father, but my pastor nurtured me like a father. He treated me like I was his own daughter. For instance, I was nineteen when I moved in but I still had a curfew. He tried to teach my responsibility. He is also the first man that I lived in a house with who didn't try to take advantage of me. You want a man (father, husband, etc.) to love you, but you're afraid because you think all they want is to hurt you. Besides my aunt's boyfriend, I had an uncle who asked me to let him see my body. He said he had been watching me. (When I was 8, I was fully developed—I was a little girl inside of a woman's body. That drew attention to me but I couldn't help it. I didn't want it to be that way.) He said he would pay me $100 for every time he could see me undressed. He even put a hole in the shower so that he could see me. When he said that, it scared me so bad that I called my mom. She showed up with her shotgun, ready to kill him. I also had a cousin who tried to have intercourse with me when I was 14. He told me that if I didn't, he would take it from me. Needless to say, I didn't trust men growing up. Living with my pastor, I knew it was just a matter of time before he tried it, too. One night my Pastor's wife left town and I knew something was going to happen. But, nothing happened. He was able to build my self-esteem in a trusting, daughter-father way. I trusted him like I never trusted anyone before.

His wife taught me how to be a young lady. She also showed me how to be a mother and a wife. I watched them pray every morning faithfully. To live with your pastor and his wife and see that they're not playing church strengthened me. It was not like the churches I had been to before. They weren't pretending to be one thing and then being another. That strengthened me. I was able Because of that, I was able to open up and share with them who I was and what had happened to me. That, in turn, started the healing process. Moving to Hartford ended my pain and started the healing process. The move

also facilitated two of the most important things in my life: getting married (having a family) and becoming a teacher.

* * *

I remember I had a dream one night before church. I was in an airplane and was extremely nervous because of all the air pockets (the plane ride was very rough). The stewardess couldn't get me to calm down, and so she went and got this man to help me. He calmed me down and when the plane landed, we left together. You can imagine my surprise when I went to church the next day and met 'this man' for the first time. I said, "Hey! I know you." I had never met him before (outside of the dream), but I knew when I met him that I wanted to be his wife.

My friend Diane actually set us up on the first date. We went on one date and the people in the church started talking about how they had dreams about us getting married. This bothered my husband so much that we didn't talk for six months. One day, I gave a testimony about how God provided work for me in Hartford when desperately needed to move from Lake City. At the end of the service, he walked up and had this gleam in his eye—I knew he still liked me! I called him and he started telling me that he really wanted to go out with me. Before we went out the second time, he took my pastor out to dinner and asked him if he could marry me. When he asked me, I was jumping up and down on the inside. However, I calmly said, "I'll have to think about it." I wanted him to suffer because he made me suffer for six months. I waited about 30 seconds and said yes. He was only the second guy I ever trusted. He is a good husband and a good friend. I couldn't have chosen to marry a more wonderful guy.

* * *

I was in Hartford in 1992 and was listening to a speaker talk about fulfilling God's plan for your life. He told us that, "Your calling is your destiny. Your destiny is something you can't get away from. It's what you're good at." I wanted to be a hair designer, and I knew that I could make good money doing it. However, with my family's help, I decided to follow what was deep down in my heart. After my first son was born, I returned to school to become a teacher. I had always taught when I was younger, whether that was to my older relatives or my younger siblings. My family used to laugh at me because everywhere I went, children would follow. I knew in my heart that I could impact children in the same way that I was impacted. That was my destiny. That was God's plan for me.

I started in education at Hartford Community College. I was so focused and at peace with who I was and what I was doing. And, my grades showed it. I had all 3.5's and 4.0's. So, I decided to transfer to the major university in Hartford. They rejected me twice. I was so angry the second time that I called and made an appointment with the person in charge of admissions. I told him that my letter of rejection stated past grades indicated I might not succeed in a rigorous environment like Hartford University. I asked him how and why they

dared to judge me without knowing who I was. Did they know what I had been through or what I had seen based on my academic records? Did they know that I had to work and support two younger children while I living through hell? I calmed down a little and explained more of my situation.

> I'm not the type of student who had everything laid out for me. I had to work and take care of people that I cared for. I had all these things that prevented me from being the type of student I wanted to be. Now I'm here, and I'm ready. I know I can do a good job.

His mouth dropped open; he told me that I was the first person who ever scheduled an appointment to come in and ask them why they got rejected. Furthermore, he told me that they would indeed accept me because it was obvious to him that I was the type of person that would do a good job. "Visiting me here says something about your character and your willingness to try." All I knew is that I wanted to go to school. I fulfilled my dream and graduated from Hartford University with a 3.67 grade point average (on a four point scale) and a teaching degree.

* * *

Do you think I'm bothered by that? Don't feel sorry for me, I'm not a victim. I will survive.

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