Chapter 5 –Lessons Learned

5.0 Overview

The major lessons drawn from this thesis include:

- Technologically rich, learner-centered environments do fit with and can succeed in Thai culture
- Rather than being deficient, there is tremendous knowledge, experience and expertise indigenous to Thai culture that provides a firm base upon which to build and leverage new knowledge. We believe this to be universal and not merely limited to Thailand
- Working from projects of real interest, often based upon acting upon the real situations of the people, provides a basis for leveraging the existing knowledge and creating new knowledge
- Using computational technology in a constructionist, expressive way helps to mobilize the existing knowledge, helps make knowledge, previously abstract and inaccessible, concrete and appropriable
- The grammar of school often interferes with powerful learning environments and activities
- Use of this technology is viable even in impoverished and remote, rural areas
- Teachers with minimal education themselves and no previous access to technology can function at a very high level both with the technology and with new methodologies for learning
- Teachers must be provided with adequate time and resources to develop their own fluency and experience with both the new learning methodologies and technologies

- Resources and support must be provided to reflect upon, discuss, and improve practice on an on-going basis
- Using a dynamic, emergent approach to reform facilitates cultural appropriation and adaptation.
- Enabling everyone at each level to participate as designers of the learning environment not only facilitates learning of immediate domains, but also helps provide a consistent basis for practice of the principles of democratic environments

In the subsequent sections I will examine the above items.

5.1 Thai Culture versus Thai School Culture

Project Lighthouse succeeded in dispelling the initial objections raised about its feasibility. Learners sitting quietly, not asking questions, only following instructions, not taking initiative, not being technologically savvy, not being innovative, not collaborating, not being adept at problem solving, may be a part of Thai school culture but they are certainly not consistent in Thai culture as a whole. Quite the contrary! The innovation in indigenous technologies, the resident knowledge in the engine culture, the entrepreneurialism of the women's cooperatives, the voluntary participation, the initiative and wealth of projects, the ability of the teachers and learners all demonstrated the vibrancy, vitality, creativity, and competence in the Thai culture.

Rather than being deficient in ability to understand, learn, and perform, there is a wealth of resources and ability resident among Thais of all social strata. These talents did not

begin with project Lighthouse. They have existed for a long time. The learning environment within Project Lighthouse enabled these talents to emerge, be recognized, and built upon.

While all of our Thai colleagues, including the educators, were well aware and quite proud of the local technological knowledge and innovativeness, it did not occur to any of them to refer to this native expertise as a basis of strength upon which to build in the learning environment. In fact, there is virtually nothing written elsewhere about the growth of this knowledge after the introduction of the internal combustion engine. This work is among the first to begin to document the effect. The deeper point for educators is that all too often local knowledge and interests are ignored and not taken as strong foundations upon which to build and from which to connect, and the grammar of school and a fixed curriculum are adhered to even when the results are thoroughly disappointing to all concerned.

5.2 Building upon Local Knowledge and Interests

Time after time we witnessed people who had not done well at school construct quite impressive projects. Accomplishing these projects required significant knowledge that school and society deem important. Yet, if one takes seriously a curricular approach, with its attendant prerequisites to knowledge and its recognition of particular formal descriptions of this knowledge, then these accomplishments should not have been possible, or at least be an anomaly.

When we first met Ae we discovered, rightly, that he was quite an impressive person. He believed he could figure out whatever he wanted, and, if he desired, would learn to do anything that felt interesting and worthy of pursuit. However he had never considered school learning as relevant to anything he really wanted to do. His experience at the workshop made a bridge for him between the kind of learning with which he felt personally involved and the kind of knowledge that he had previously only encountered in a school context. Thus, it opened the way for him to pursue more formal study and develop an ambition for a more sophisticated career. He now is a partner in operating a private computer school.

Then, once we met the motorcycle mechanics students in Lampang, the technical teachers in the Chiang Rai Non-Formal Education center, then Denchai, and so on, we noticed the pattern of experience all of them shared. They all spent a considerable amount of time around engines, learning in an informal culture. They were able to mobilize and leverage their experience gained from one general purpose technology, the combustion engine, to address other domains of interest and importance through the mediation of another general purpose technology, the computer.

This broadly shared expertise within Thai culture not only was not recognized for its intellectual depth but also went virtually unnoticed. People concerned with the development of Thai society, worried that Thailand would not be able to develop their economy based upon knowledge-based industries due to the lack of technological innovative, problem-solving, and collaborative capabilities, mobilized to initiate Project

Lighthouse. What they did not recognize were the accomplishments, expertise, and capabilities demonstrated within Thai culture. Thai learning institutions also did not recognize this talent and thus not only could not leverage and build upon it**, these institutions often tried to squash it**. Each of the innovative, mechanically capable people with whom we worked was profoundly unhappy in school primarily because School did not let them do meaningful things. Freeing them to use their experience and bridge from it to projects of interest to them freed them to display their talents. Each of them has moved on from rather low-paying work with limited futures to technologically-based work.

5.3 Connected Projects

We witnessed people who had not done well at school construct quite impressive projects. Often these projects addressed real world concerns. Accomplishing these projects required significant knowledge, knowledge that school and society deem important. Yet, according to a curricular mindset, with its attendant prerequisites to knowledge and its recognition of particular formal descriptions of this knowledge, then these accomplishments should not have been possible, or at least only be anomalous.

A salient feature of this work, particularly in the rural areas, was the work on real-world projects as a basis for activity. Paulo Freire initiated this approach in his work with rural poor in the northeast of Brasil [Freire, 1972]. He engaged them in discussion about their situation and they searched for causes and remedial actions. Through this, people learned to read and write, to learn history, to do math and science, to study society. They did not

just study for the sake of studying, however. They questioned and worked as a means of taking control of their lives and environment. What they learned was not isolated and decontextualized, but rather it was integrated into their understanding of and acting upon the world. The knowledge and the process of gaining knowledge were tools under their control applied for their purposes.

The choice of projects and study by the learner is critical. We do not use projects merely as a means to get them to learn what we want. They are not pre-ordained, pre-planned, and prefabricated within a pre-determined, structured, rigid curriculum, used solely to teach a set of facts or concepts. Rather, their choice is an essential element to a positive, free, active engagement with their world. Instead of relying on the dictates of others, they take charge of their own learning and their own relationship with their environment and each other. The process of critically questioning the way things are, determining on what to work, choosing among alternatives, designing the projects, working cooperatively, analyzing the results, debugging both the process and the methods of action, and recursively beginning anew, is important in its own right as well as for any learning activity. While at first people may not perform this process well, there is no way to get better at it except through critical practice.

Through our use of computational technology, the work described here has a tool not available to Freire and his colleagues at that time.[1] We use the computer in the spirit of

[1] Freire and colleagues began using computers in their projects beginning in the late nineteen-eighties. When Freire was Secretary of Education for the city of Sao Paulo, they began Project Genesis, which created four pilot schools using a relatively high density of computers. In that project, the school community would get together and decide their theme for the year, around which they would base all work.

Freire's original work, that is, as a tool for critical questioning of and engaging with the world. However, computational technology affords new opportunities for investigation previously unavailable or difficult with other methods.

We were able to create *dynamic simulations* in *microworlds* to test various possibilities when researching where to place the dam, how to layout of the agricultural fields, how to re-design the irrigation system, which methods of rice growing worked better, what new business venture (e.g. mushroom, vegetables, rice products) to attempt, and so on. This is not only important and effective in rural regions. Previous work demonstrated how investigating urban issues also can produce tremendous learning and social effects [Cavallo, 1996a, 1996b]. The *social capital* [Bourdieu, 1977] gained by mastering and utilizing advanced modern technology also often produces a leveraging effect among those who do not have social status.

Another leveraging characteristic of computational technology is the ability to make previously abstract representations *concrete*. School has been empowered but also limited by the technology of the book. Creating dynamic simulations was extremely difficult prior to the computer. The calculations necessary were difficult and abstract. It took many years and much practice to prepare for this arduous work. The pathways and even the representations and ways of thinking about the problems are dramatically altered by computational media. Mapping the terrain for the dam project provided a concrete basis for understanding and calculating distances, maintaining proportions, dealing with area, and so on. Simulating within a microworld helped make concrete determining volume,

water flow, and accounting for evaporation and drainage. Just as we have seen young children understand previously difficult and abstract mathematical concepts like variable or recursion through programming in microworlds, so too does the complex mathematics underlying the dam and other projects become concrete, contextualized, and familiar. Mathematics becomes their own connected and concrete expressions under their control for their purposes, not an alien language or ritual without significance.

The use of programs and their components (e.g. functions, variables, data and procedural abstraction, objects and properties, conditionals, concurrency) provided tools of formal expression for the villagers to apply concretely to their projects. Through time (although for Denchai and others this time was minimal), these became familiar tools just as their wrenches, screwdrivers and the like were familiar. *They were formalizing, not recalling formalisms*. Jean Lave pointed out how many people did not typically use the formalisms taught in school on their everyday problems in the grocery store or kitchen [Lave, 1988]. Yet, they still applied some type of formalizing to determine best purchases or proper proportions. Here, they created and applied the formal expressions of their programs towards the real and concrete problems they faced. The world provided an objective test for the robustness of their formal expressions. This is practicing and learning mathematics at its best.

We see from the examples of the mathematics of the Brasilian street children or the examples in Lave that people can master the mathematics they need for everyday living [Nunes and Bryant, 1996, Nunes, Schliemann, and Carraher, 1993]. This work extends

that according to an important basis for learning mathematics in the first place. The Thai villagers are applying sophisticated mathematical thought to their issues and goals. They are expressing in formal terms their ideas about how things work and how things might be different and improved.

A pivotal issue in working on projects of people's own choosing in a Freirean way is *control*. People trust educational institutions to help instill principles of democracy and freedom. Yet these institutions are typically quite autocratic. Learners do not get to participate in meaningful decisions regarding their own learning and development. Villagers feel that schools in places like Nong Baot have no relevance to their lives. They do not get to engage meaningfully or effectively in what is important to them. Neither do they get to have an impact on their environment.

This work begins to change that situation. *Not only do the participants have a share in the control over their activities in the learning environment, but also this control is extended to their living environment*. They practice critical questioning of and engagement with their world. They change their agency from passive (or resistant) to active. Rather than waiting for others to examine, decide, and act, they take these roles for themselves collaboratively. This fundamentally changes their relationship to their environment, the institutions around them, and among each other. Rather than waiting for the government to build a dam and fail (!), they take this on for themselves. Rather than wait and stagnate, they investigate and create new business cooperatives like mushroom farming or vegetable growing. The feeling that one cannot do difficult things because one

is “just a simple villager” is replaced by feelings of competence. As one villager in Nong Baot expressed, “I stayed awake all last night because I realized how little I have done and how much more I can do. I feel like I have wasted so much time but now I am anxious to use what I am learning to improve life in my village." Another told us that "I used to feel that math was chaotic, with numbers floating all around. Now I can pigeon-hole them and give them meaning. I can use this to better decide what to do.” While these are self-reports to a receptive audience, the speakers' changes in actions also attests to their changes in beliefs. It is these changes of sentiment, more than learning any subject, that is the most important outcome of this type of engagement.

Just as Lave illustrated how much school learning is decontextualized and disconnected from the lives of most people and thus is later left unused, others have joined this trend, perhaps in less thoughtful ways, and advocate "authentic" activity as a basis for schoolwork. This movement arose as a reaction to schoolwork children feel disconnected from their interests and experiences and irrelevant to their lives. Moreover, because there is little connection and involvement, there is little recall or use in other, real-world situations where the learning is intended to be applied. Thus, the advocacy of authenticity. While some attempts by textbook publishers trivializes this concern by using the same problems and examples and merely substituting brand-name products such as certain sneaker manufacturers or types of candy for use in mathematics texts, others are more serious by studying biology through investigation of pollution in the local stream. Still, this focus on authenticity by virtue of appearance in the real world misses a major point.

As this section detailed, learners within Project Lighthouse certainly focused on many authentic problems and gained in many dimensions through this process. However, virtually all of them simultaneously also constructed projects in imaginary or even frivolous domains. For example, many constructed playful animations, computer games, multimedia stories, and other such arguably *inauthentic* projects. Still, they benefited not only from that experience directly, but they also benefited in their construction of the real-world projects from the technological fluency gained in the more fanciful, playful projects.

Important to this success was that all of the projects were chosen by the participants. The projects achieved authenticity not by the domain or connection to the real world, but because the choice was in the control of the learners who were not being coerced to do something they did not want to do. While the learners developed a more sophisticated, robust fluency through computational expression in multiple projects, the more fanciful projects were not used merely as an exercise before attempting the real world projects. The expressive nature of the tools allowed them to develop fluency with computational thought in their own vernacular and towards their own interests. Whether these interests were in making games or making dams, they remained *connected* to their interests, passions, and ideas, and, therefore, authentic.

5.4 Constructionist Computational Technologies

The mathematics of the dam and other water projects in Nang Rong were significant and varied. As the mathematics were situated in real world problems, they were not so obvious as in textbooks where the questions test the material recently presented. In our work in Nang Rong, how to represent a problem, what to do, what types of mathematics to use, how to express it, thinking mathematically, combining algebra, geometry, computation, and even some calculus, and coming up with viable answers, were all integral parts of our work. In a School sense, this is much more difficult than School math. Yet, our participants, teachers and students alike, did this work successfully. In a School sense, this should not have been really possible as they did not go through and pass the prerequisite mathematical knowledge.

Lucy Suchman, in her book **Plans and Situated Actions** [Suchman, 1987], described differences between how navigators explained what they did and how they actually performed. Their explanations were perfectly rational and reasoned, and they implied that it was this reasoning that guided their actions. However, she demonstrated that this capability was really post hoc and just an explanation for justification.

School curriculum often functions in the same way. Once we have learned something, we can look back at how we construct the logic of the domain. We look at what bits of knowledge are the basis for others. The potential pitfall for curriculum developers is that we then assume that we must learn the domain in the order of the building blocks. Is this truly the case, though?

In Nong Baot we saw the people use the mathematics for their projects. The more projects they did, the more fluent they became with the mathematics. We did not spend years preparing them for the high school and university level math they performed. Still, they accomplished everything they needed. Likewise, we did not spend years preparing them for the programming and computational thought they performed. Again, they accomplished everything they needed. They truly were developing their fluency with mathematics and computation, working on difficult, real world, conceptually rich projects of their own choosing.

There are similarities in this work and other work recognizing mathematical knowledge and use in informal settings. Foremost among this is the work with Brasilian street children (Nunes and Bryant, 1996, Nunes, Schliemann, and Carraher, 1993) and the work of Jean Lave (Lave 1988, Lave and Wegner, 1991). In the work with Brasilian street children work the researchers demonstrated the capabilities of the children in dealing with mathematical problems when the problems were posed in situations with which they were familiar from their lives in the streets. However, when the same conceptual problem was presented in a school context, the children could not perform the same calculations they performed when dealing with street situations. Their deficiencies were not in intelligence or even mathematical ability, but rather in handling a decontextualized, not personally meaningful, school context.

Likewise, Lave demonstrated how people really solve mathematical problems in real situations. The people she studied did not use conventional school formalisms, yet they

were proficient in solving real world math problems in the kitchen, in the grocery store, and so on. Lave successfully challenged the school mindset of math learning and proficiency for the real world.

A significant attempt to restore principles from learning by doing and providing context and authenticity to the work of learners falls under the rubric of the *cognitive apprenticeship* and *situated cognition* [Brown, Collins, Duguid, 199x, xxx yyy]. While there is no definitive treatise on cognitive apprenticeships, and thus it is not possible to specify exactly what they are, for the most part they invoke the image of apprenticeship learning as in a craft. They advocate learning in the practice of authentic work, not merely school busywork. They add the modifier cognitive to apprenticeship to emphasize that one can not merely learn crafts such as carpentry or masonry via apprenticeship, but also more typically academic domains such as math and science. Learners work on actual projects under the tutelage of masters in the domain, the role for the teacher. They begin with simple tasks and work their way to more complicated ones as the apprentices gain mastery.

Jean Lave and Etienne Wegner attempted to "rescue the idea of apprenticeship" from over-generality by delineating what they term *legitimate peripheral participation* (LPP) [Lave and Wegner, 1991]. They write:

> In our view, learning is not merely situated in practice -- as if it were some independently reifiable process that just happened to be located somewhere; learning is an integral part of the generative social practice of

> the lived-in world… Legitimate peripheral participation is proposed as a descriptor of engagement in social practice that entails learning as an integral constituent. [p. 35]

Lave and Wegner restore primacy to activity in contexts without resorting to over-simplification. After describing a number of apprenticeship situations, they add:

> …researchers insist that there is very little observable teaching; the more basic phenomenon is learning. The practice of the community creates the potential "curriculum" in the broadest sense -- that which may be learned by newcomers with legitimate peripheral access. Learning activity appears to have a characteristic pattern. There are strong goals for learning because learners, as peripheral participants, can develop a view of what the whole enterprise is about, and what there is to be learned. Learning itself is an improvised practice: A learning curriculum unfolds in opportunities for engagement in practice. It is not specified as a set of dictates for proper practice. [pp. 92-3]

While compelling, their version does not account for the type of learning witnessed in Thailand. Perhaps not surprisingly, the contexts they investigated were apprenticeships and everyday life. Although they add considerable depth to understanding how apprentices learn, it is straightforward to view apprentices learning within as legitimate peripheral participants in communities of practice. They also note the role of children as learning as legitimate peripheral participants in adult world.

What, however, would be the community of practice in the Thai situation? The participants are quite at the center, more in control. What is learned also goes beyond learning math by being in a community of practice of mathematicians. Participation while immersed in a constructionist mathematics culture is a key component of our learning environment. However, the integrated nature of the environment extends beyond mathematics. With emphasis on control and critical questioning of and engagement with their world, developing fluency with mathematics and computation become tools for this engagement.

In *An Exploration in the Space of Mathematics Education* Seymour Papert challenges his readers to consider not merely reforms of mathematics education, but complete alternatives [Papert, 1996]. He proceeds to propose a number of dimensions on which to judge among the alternatives. One critical dimension is on the empowerment and disempowerment of ideas. Much of our work in Project Lighthouse was around this dimension. It could be argued that the school experience of the Thai villagers with whom we worked fell on the wrong side of the empowerment axis. Their mathematics instruction led them to feel not merely that the school lessons were irrelevant, but this was also internalized as not being intelligent, as just being "simple villagers." Yet, when having the opportunity to work on projects significant to them, the mathematical ideas were empowered, and, subsequently, they felt empowered.

William Thurston in his essay *On Proof and Progress in Mathematics* discusses what it is that we do when we practice math and makes some proposal about why we do it.

> …as mathematics advances, we incorporate it into our thinking. As our thinking becomes more sophisticated, we generate new mathematical concepts and new mathematical structures: the subject matter of mathematics changes to reflect how we think. [Thurston, p. 340]

He goes further in discussing why programming is a legitimate and important operation within this endeavor. The work of the Thai villagers provides an unlikely but compelling site as an example of Thurston's ideas. He writes "The standard of correctness and completeness necessary to get a computer program to work at all is a couple of orders of magnitude higher than the mathematical community's standard of valid proofs." [p. 347] He adds "There is a real joy in doing mathematics, in learning ways of thinking that explain and organize and simplify." [p. 349]. And also, "Finally and perhaps most importantly, a mathematical breakthrough usually represents a new way of thinking, and effective ways of thinking can usually be applied in more than one situation." [p. 350] While he is talking about professional mathematicians, the statement is just as compelling when thinking about Thai villagers and mathematics, or children anywhere and mathematics. In our work we are attempting to enable people to feel the joy and the power of such mathematical thinking and fluency.

The role of constructionism within this endeavor cannot be underestimated. It can be argued that a constructionist approach is what enabled the connection to the local

knowledge of the engine culture of the young men, as well as the entrepreneurial culture of the women's cooperatives. By constructing real projects of real concern to them, they discovered the need for fluency with powerful mathematical and computational ideas. By working in cultures where there was knowledge of and passion for these ideas, the learners were able to construct their own understanding of these ideas. Rather than being "simple villagers" incapable of doing complex math, they were learning their own capabilities by their critical engagement with their world.

5.5 The Grammar of School and Powerful Learning

A primary goal in Project Lighthouse was to break mindsets about how learning takes place and what learning environments should look like. The success in connecting to the indigenous knowledge of the people, particularly those who had not previously done well in school, provides an existence proof of the possibilities. The fact that these powerful examples occurred out of the traditional school context questions the status of existing school methodologies.

If we look at school reform as a design problem, rather than as an existing entity to be incrementally modified around the edges, then we can see certain factors in a new light. Rather than taking certain elements as given, we can view them as design choices. Too often school reformers take as inviolate constraints elements that actually could, and should, be variable. An example of an interesting, well-designed project provides a salient example of this.

Janet Kolodner and some colleagues at Georgia Tech University also stresses the importance of design. They designed a very nice, thoughtful activities that placed the students in the position of designers on open-ended problems [Kolodner et. al., 1998]. One module is "Vehicles in Motion" which presents several design challenges to students. One challenge is to design mechanically-powered vehicles to carry heavy loads over a hilly terrain and another is to design balloon-powered systems.

Unfortunately, the constraints of the school interfered with the activity. They write "where we integrated designing with investigation and where we made sure that students were constructing and testing the devices they were designing, we found that *construction took too much time, that it required 'authentic' materials, and that teachers needed to understand the underlying science well to be successful facilitators*" [italics added]. The authors themselves state that the changes through time to there approach left "It is also far more structured and focused than we could have imagined."

What was their reaction to the limits? They decided to eliminate the harder, more time consuming elements of the project. Rather than have the students design their solutions fully, they only let them choose parameters and make small choices within a provided environment. Thus, they eliminated the primary elements that made the project interesting and fruitful. They did not do so because they felt it created a better learning environment. Rather, they did so in order to fit into the constraints of school as it is. When the constraints of school processes debase learning activities, then why do we not question and change the very processes that limit the learning potential?

5.6 Technology and Poverty

It is a legitimate question to ask whether it is wise to spend the considerable amounts of money on technology for children and learners in areas of poverty. Early experience shows that deploying technology can be an important component in human and economic development. However, this can only be understood in the long term and the project is still too recent for a judgment.

However, certain factors are critical. Participants in Project Lighthouse did not suffer from extreme poverty. To our knowledge, everyone had at least minimal shelter, food and clothing. Thus, donations of technology did not replace potential donations of necessities for subsistence.

The cost issue is rapidly changing, even in the short two years of Project Lighthouse. The price of computers is dropping dramatically. There is no technical reason why this should not continue. It is feasible that viable computers for children could be available in the very near future for under two hundred United States dollars. This drastically changes the cost equation.

Maintenance does need to be the large expense that it often is in educational institutions. Rather than being a pure expense, it can be a learning opportunity. Students who want to receive vocational training can practice and learn on the equipment. Rather than paying to install, maintain, debug, and diagnose system, network, and application software, the

students can also learn by doing this. This makes much more sense than training in inauthentic situations and simultaneously reduces costs significantly.

An early experience in Project Lighthouse can serve as the final point on this matter. On Papert's first visit to Thailand he was taken to a school in Bangkok. Upon visiting the computer lab, he saw a number of brand new Pentium machines. However, almost half of them in the lab were not functioning. When asked why, he was told that they had been broken for some time but the school always had tremendous difficulty getting repair people to come to service the machines.

When he subsequently visited a computer lab in the rural north, he noted that all the machines, none of them new, were functioning. He asked the woman in charge if they ever broke. She replied that of course they did. He inquired what did they do when they broke. She responded that she would get all her friends together and they would jointly try to figure out what was wrong and how to fix them, and, until the present, they had always been successful. This was our first encounter with the bricoleur spirit in rural Thailand.

5.7 Teachers' Capabilities

Another salient observation with an important bearing on the assessment of the world's learning potential is the pattern of learning we observed in teachers. An assumption that runs through discussion of education reform in developing countries is that most teachers, especially rural teachers are "under-qualified" and incapable of learning and teaching

advanced new ideas. However, our observations in Thailand that go directly against this assumption are consistent with what we have seen in other places, especially Costa Rica. In many ways the so-called under-qualified teachers turn out to be more capable of learning new methods! And, in particular, the constructionist approach taps into and draws out their expertise, sensibilities, and experience.

Just as many of the young learners could build from their experience with engines, so too could the rural teachers. Just as many of the young learners were competent bricoleurs, so too were many of the teachers. Just as working from real projects connected to the interests and expertise of the learners, so too did it connect with the teachers. In this situation, rather than working from a position of weakness in relation to the power and structure of academic institutions, these teachers were now working from more of a position of strength. They were able to draw upon their own experiences, their own interests, and work on projects of benefit to themselves and their communities. The teacher in Nang Rong who worked the most on the dam and irrigation projects actually asked me if he could continue to work with the villagers on these projects after I left. He insisted upon how important it was. When I told him that their continuing was the whole idea, he began working even harder.

Some policy-makers and economists have commented that the constructionist use of technology for learning environments in developing countries works well among the elite there, but is not viable for the majority of people and situations. This work provides an existence proof that this assumption is wrong.

5.8 Development Time and Fluency

Before beginning Project Lighthouse we proposed that the teachers participate in six weeks of workshops and have at least six weeks to develop their own projects. We believed this to be the minimum amount of time to enable them to begin working with students. Even this amount of time is merely a beginning.

As the fits and spurts of Project Lighthouse demonstrated, the accomplishment and development of the rural teachers required an intervention. They needed the opportunity, time, and access to people and resources in order to develop their own fluency with the new methodologies for learning and new technologies. Providing only a rudimentary introduction certainly opens minds, provides a basis for introductory work, and allows people to learn the syntax of the languages and the methodology. However, the deeper results arise from having deeper understanding and rich experiences. While we witnessed this with some of the participants, for the most part too many of the teachers were not allowed adequate time to learn, to develop their own projects, to discuss ideas with their colleagues and others.

Yet, we find repeatedly that administrators do not want to allow such development believing it is too costly. However, this view of costs is short-sighted. While it certainly is a cost to free teachers for such an amount of time, there is a much greater long-term cost because teachers are often afraid to go into domains they do not know well and work with materials with which they are not comfortable. This later impedes the progress of

the learners and of the learning environments. The social, educational, and, arguably, the economic costs of this is the long-term far outweigh the initial develop-mental costs.

Unfortunately, we saw several instances in Project Lighthouse where promising projects were aborted because the teachers lacked the confidence in their abilities both technically and also pedagogically. Rather than dive in and try whether they knew or not, they were uncomfortable placing themselves in a situation where the learners could see they did not know the answers. While often this makes for powerful learning situations as the learners can see how a more expert learner, the teacher or adult, goes about learning and working on problems when the answer is not known in advance, the teachers, accustomed to a more rigid, predictable, rote-learning environment pulled back. While understandable, this was quite unfortunate. This lack also reflects upon the need for support and mentoring for the teachers, which, while planned, did not occur at the level needed. This is addressed more fully in the subsequent section.

5.9 The Need for Mentoring, Research, and Discourse

Another critical element to the project that was never put into practice was the creation of a "Fellows" program. Our goals for the program were to:

- mentor and support the sites
- provide expertise in the target pilot areas
- research and document the project
- help disseminate the findings
- help educational and other institutions appropriate the positive results

- promote a better public discourse on learning

However, we were never successful convincing the Thais of the necessity for such a body. The Suksapattana Foundation ran according to the way of most Thai foundations. Certainly, Khun Paron and Khun Bangkok Chowkwanyun, and previously Anita Horton, worked tirelessly on the project. They opened many doors, coordinated and managed all activities, spread the word about the project, and learned a considerable amount about learning and technology. Yet, in some ways the project did not progress as hoped simply because despite the intelligence, talents, and incredible efforts by the people mentioned above, the goals for the project through the Fellows program were beyond the capability of any two or three people to accomplish.

5.10 Emergent Design

Popular views about design, about reform, about planning, about control typically lag behind progress. New organizations are pioneering new means of control and change. Emergent design is the recognition that certain systems are too complex, dynamic, inter-connected, and chaotic to attempt to manage them by top-down, pre-planned, rigid means of control. Large educational systems are one-such system. The human brain is another. That this project is simultaneously involved with both systems is all the more reason to take an emergent approach.

The assumption of this work, leading to its advocacy of emergent design, is that no matter what one plans and does initially that there will be surprises, that people will not

and should not blindly follow but will construct their own understanding of their work and roles, and adapt according to their beliefs and positions. This is not a deficiency. Rather, it was the ability to be open that enabled us to see plainly the energy and expertise of the youth in the engine culture and the women's cooperatives. Indeed, if one is to follow the interests and expertise of the learners one must be prepared to adapt and continuously revise plans and activities. While this was a tenet of Dewey, modern computational and telecommunications technology unavailable to Dewey and those who followed him enables the creation of such environments on a broad scale.

By utilizing emergent design, Project Lighthouse was able to expand to Mae Fah Luang and Lampang immediately. This produced excellent results in each site. This enabled each site to focus on the activities most meaningful to that particular site. Each site used the same constructionist principles, the same technologies, and the same focus on technological fluency. However, each site developed according to its own special needs, interests, concerns, and culture. In this way, rather than every site everywhere following the same set curriculum over the same time period regardless of context, interest, or social situation, each site is free to maximize its efforts. Moreover, transferring control to the sites and to the learners is important in its own right for the development of responsibility.

5.11 Design All the Way Down

One can think of a radical reform as a learning project through and through. Activity and mindset are different at every level, whether administrator, teacher, or learner, than they

were in the previous formulation. As such, it makes sense to employ the best means for learning for every level and every person. In our formulation this implies a constructionist design and activity consistency throughout the project. Thus, there is constructionism *in* and *of* the learning environment. As design is shown to have tremendous potential for learning, we extend the design of the learning environment all the way down through the project.

In traditional reform efforts, the reformers achieve the best understanding of the goals and methods of the reform because they are the ones constructing them. It is then up to them to transmit these goals and methods throughout the large, widespread organization. While the reformers may be pleased with themselves, in practice this rarely, if ever, works. The mindset of the reformers is to blame the quality of teachers, or administrators, or even the students for not implementing their plan properly. However, as many have observed in other domains, this is always going to be the case [Shiba et. al. 1994]. People will implement based upon their own understandings, their own points of view, and their own goals. In such systems where the understanding of everyone, not merely the upper management, is the key element, then obviously the development of each person is critically important. For them to develop, they need to construct and take responsibility on their own.

Clearly, this will not happen without *mistakes* being made. However, the word mistake is somewhat misleading. We often learn best from our mistakes. If one is not allowed to make mistakes, then there is little chance for exploration, for reformulation of ideas, for

learning. The other side of the equation is that imposing one's will on those below may get the immediate activity desired, but will also create other undesirable side-effects.

An example of the positive effect of design all the way down is the development of the teachers and coordinators of Project Lighthouse. If the MIT group had made a fully detailed five-year plan as some requested, this would have denied the opportunity for development of all the teachers who put so much effort into the project as practitioners, researchers, and leaders. The coordinators such as Khun Paron, Dr. Suchin, Khun Bangkok, Ajan Jirachai, Ajan Ackachai, Anita Horton, and so on, would not have had the opportunity to develop as they did. Their comments and understanding of learning and learning environments from the beginning of the project to the current time have grown tremendously in depth and complexity. Not only did they develop, but also the project was tremendously enriched by their growth and initiative.

A natural conflict often emerges when people at all levels are empowered. Those at the previously higher levels may resist the changes and the loss of authority. However, for any project that strives to be democratic and help people to develop autonomy and responsibility, then this is a necessary conflict to emerge. Learning to coordinate and collaborate in new ways of sharing control was a goal of the project, and, indeed, emerged within the coordination of the project itself.