

Constructionism in the Era of One-to-One Computing: A Case Study from Thailand

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Abstract

The purpose of this study is to investigate how new learning possibilities could take place in environments where students are saturated with laptops. Specifically, this paper draws upon in situ examples collected from three schools over a one year period to highlight the integral role of the technology, the people, and the institutions involved. This work has identified a significant difference in the nature of the learning activities observed between the schools. Among the three observed sites, one was a rural community-oriented school. The learning activities were primary driven by issues in the community and extended beyond the walls of the classroom (Figure 1 shows an example). The other two sites were urban schools and the learning activities there were governed mainly by the national curriculum. Despite the differences, this work has found that the core driving forces that govern the success or failure of the learning innovation remains significantly similar.



Figure 1. Students taking pictures of plants in a near-by forest using the laptop's built-in camera.

This paper presents a theoretical analysis of the case studies from Papert's comparison of Piaget's assimilation and accommodation process to how schools are embracing or resisting learning innovations. We further discuss the case studies from a conceptual framework where change itself is treated as a learning process. Thus, interpreting what is seen requires one to understand that the process is emergent, situated, and needs to be understood holistically.

Keywords

One-to-one Computing; Case Study; Holistic Interpretation; Thailand

Overview

This paper describes and analyses learning innovations collected from Thailand's first longitudinal study of learning environments with one-to-one laptop. Three schools are described, all of which have adopted the constructionist learning philosophy (Papert, 1980) in their own ways before the one-to-one laptop program. The goal of this paper is to describe case studies that took place and try to better understand the implications at a macro-level using recent, and perhaps less talked about, arguments given by Papert and his colleagues.

Papert has long advocated that schools are about to go through a radical paradigm shift (Papert, 1980). His early predictions about computers being ubiquitous in schools have been realized. Further more, the dream of having laptop computers in the hands of every student is not a distant reality. While the material aspect of Papert's vision has come true, his foresight of a fundamental change in the learning process has yet to take root in any clear way. This issue has been a subject of many studies and debates (See Cuban, 2001; Warschauer, 2006; Collins & Halverson, 2009). Papert has responded by positively suggesting that school's resistance to this inevitable event is similar to the assimilation process described by Piaget. In the end "assimilation eventually gives way to accommodation and in Piaget's view the temporary conservatism plays an essential role in preparing for the change" (Papert, 2002). This work uses this perspective to discuss the characteristics of the case studies.

Papert has also argued that changes in schools are better supported by an evolutionary process as opposed to a deliberate reform design (Papert, 1997). Cavallo calls this process "emergent design" and compares the transformation process to cultural changes such as "better eating in America" and "paradigmatic changes in manufacturing" where small and local changes collectively play a significant role. Cavallo points out that any effort to facilitate change in learning must be situated and take into account the sociological and institutional factors as a whole (Cavallo, 2004). This perspective is used to further articulate the case studies from a holistic point of view, taking into account the social and school context as well.

The cases described in this work come from only three schools and, thus, does not make any claims about school reform or paradigm shifts in learning. Rather, this work provides micro examples of Papert's macro perspectives. If changes in the educational system is itself a learning process, this work shows examples of one possible stage in this developmental path from schools that (a) computational materials (laptops) are ubiquitous; (b) a constructionist mindset is part of the school culture; (c) the schools have received some flexibility to introduce progressive learning approaches from their superiors.

Scope

This paper discusses three sites that have used the XO-1 laptop designed by One Laptop per Child non-profit association (OLPC). All the schools have used the laptops for at least one year. Although all the case studies were done on the XO-1 machine, the focus of this paper is to present an anthropological analysis of learning opportunities with one-to-one computing and not on the particular benefits or drawbacks of the XO machine offered by OLPC. The intention is to put the spot light on the people and the institutional factors that play a significant role in the fate of one-to-one laptop programs regardless of the hardware choices.

This paper does not aim to cover all the issues related to one-to-one laptop programs. Questions regarding assessment (either test scores or other qualitative measurements), machine repair and maintenance, side-effects from game addiction or inappropriate web content, establishing Internet infrastructure, machine theft, among others will be addressed in the project's forthcoming full report (Sipitakiat, A. et al., 2010).

Background: The Schools

There were three schools involved in this work. The first site, Ban Samkha, is a small rural school while the other two sites, Ban Sankhumpang and Tessaban-4, are large urban schools.

Ban Samkha is a primary school located in a remote part of Lumpang Province of northern Thailand. There are twenty eight students and three teachers. The school has a close relationship with the village and participates regularly in community projects. The Suksaphat Foundation, a non-profit organization promoting constructionist learning in Thailand, has been working with this community since 2001 facilitating projects such as a community retail store, community broadcasting, and water management. Ban Samkha received pre-production XO's in March 2007. The machines were given to every student from grades one to six, including the teachers. XO-1 machines were made available to them in August 2008.

Ban Sankhumpang is located fifteen minutes from Chiang Mai city. It is a primary school with more than one thousand students. The Suksaphat Foundation started their work at the school in 1999 providing support for technologically-rich learning innovations. Six classrooms, one from each grade level, received laptops in August 2008. A total number of three hundred laptops were given.

Tessaban-4 is located in the city of Lumpang province. It is also a large school with more than one thousand students. The school offers both primary and secondary education. The school became connected with the Suksaphat foundation in 2007. Forty seven laptops were given to two classrooms in August 2008.

Data Collection and Analysis

This work follows the development of learning activities from the participating schools over the course of one year starting in August 2008, which was when the schools received the laptops. The data collected for this work was gathered from three main sources: (1) the researcher's observation from site visits; (2) interview sessions with teachers and students; (3) written documents from student journals and teachers' monthly reports. During the study, bi-monthly half-day visits were made to Ban Sankhumpang School. The other two schools, which are further away, were visited every two months. Three two-day workshops were held for all the involved teachers and school administrators to reflect upon their progress and difficulties. Information about activities in Ban Samkha that took place prior to this work was collected from interviews and teacher reports.

This work follows a qualitative research methodology (Bogdan & Bilken, 1992). During each school visit, we collected as much information as possible about the learning activities and anything related to the teachers and students. When new data was received either from a site visit or from teacher reports, they would be organized and broken down into groups. We would then synthesize the data to identify any significant themes that may have emerged (Patton, 1990). This approach allowed us to better steer our attention during the next school visit.

All the students that were involved in this research are primary students ages between eight and twelve years of age. The ages of students in the case studies from Ban Samkha are mixed as they do not divide their classes by age. Ages of students in examples from other schools are more specific and will be described in each case.

Case Studies in Community-Oriented Learning Activities

Prior to the laptop program, Ban Samkha School has already been involved with many "village projects" trying to involve their primary school students in thinking about local issues. The following examples show that this connection provided a fertile ground for project ideas when the laptops arrived.

Household Accounting

In the late 1990s, Ban Samkha was suffering from debt problems and villagers who cannot manage their finances were losing their homes. The village responded by creating a local debt-relief fund for those in trouble. There was a condition that those who wish to receive help must build up a good financial habit by keeping a log of their income and expenses. Soon after, many villagers, not only those in trouble, were convinced to join this practice and it became a village-wide activity. Given that many villagers were illiterate, their children became helpful in keeping the account book up-to-date (see Figure 2 left). Each month they would sum up all the numbers and reflect upon their spending in comparison to their earnings. The school played its role by assuring that the students update their account book everyday. Teachers used this opportunity to teach students language (correct spelling, appropriate selection of words, etc), mathematics (summing numbers, using fractions, etc), organizational skills (categorizing items, designing the account layout), and discipline.

This activity unsurprisingly led to the idea of using a computer spreadsheet. The idea even predated the laptops. Spreadsheets can assist students with the calculations. Graphs and other visualizations can help parents reflect on their spending. However, it was the laptops that made the idea work. Before the laptops, the teachers tried using Microsoft Excel at the school's computer lab, which consisted of fifteen donated second hand computers. The attempt failed for two reasons. First, students usually update their account book at home where they could obtain financial activity from their parents. Doing the account book in Excel meant more work because they would have to write down the transactions on paper and re-type them into Excel at school. Second, parents would have to come to the school if they wanted to participate. Printing was not a viable solution for the school. Dr. Suchin, the school's pedagogical mentor since 2001, explained that although the computers were not physically far from their homes, there was a mental barrier that deterred the parents' willingness to participate.

Since the students were allowed to take the laptops home, the spreadsheet idea re-immersed. Khru Srinuan, a teacher at the school, described that the parents immediately became interested in the idea. Being able to utilize the technology at home made the activity much more personal and lowered the existing mental barrier (see Figure 2 center). However, there were technical difficulties that arose mainly from the XO platform. It was not possible to find a spreadsheet program that runs on the XO's operating system. Thus, the students had to rely on on-line spreadsheets, such as Google Documents as show in Figure 2 (right). As a result, this activity was limited only to the students who lived within the range of the school's wireless network. The success of the technological aspect of the project was, thus, yet fully realized.



Figure 2. (Left) An account book logged by students. (Center) A parent observing a laptop brought home by her children. (Right) Example of an account book created in Google Docs.

Laptops for Early Warning of Landslides and Flash-Flooding

Ban Samkha village is located at the base of a mountain with a summit of 600 meters. Deforestation in the past decades has increased the risk for landslides and flash-flooding during

the rainy season. Such events pose a threat to villagers who often travel into the forest in search for food and other goods. Flash-flooding is especially dangerous for the school as it is located the closest to the mountain.

Responding to this danger, a weather station was installed at the village by the Hydro and Agro Informatics Institute (HAI). The autonomous station, shown in Figure 3 (left), collects information about rainfall, air humidity, temperature, and various other weather related parameters. The intention was to allow villagers to observe the amount of rainfall and determine the risk level. However, there was one problem. The information was not easily accessible. Getting data stored on the station requires one to connect it to a computer and manually download a log file. Alternatively, the weather data was automatically sent back to a server in Bangkok via a cellular network, which can then be accessed through the Internet as shown in Figure 3 (Right). However, both methods were complicated for the villagers to perform on a regular basis.

When the internet-connected laptops arrived, the students took on the role of monitoring the amount of rainfall. The teachers and the villager-head organized a system where students will be given a small credit when they alert the village of dangerous rainfall levels. Since the students normally spend a great deal of time online, this project worked out well.

Volunteers from the Hydro and Agro Informatics Institute have made regular visits as part of a routine check-up and evaluation of their equipment. This allowed the students to learn about the technology and the principles involved from the volunteers. For example, students were earlier informed by the teachers that rainfall greater than 80 mm/day is considered unsafe. But they were not able to understand what this number meant. Meeting with the HAI volunteers allowed them to learn directly from the experts. The students became connected and interested in a set of scientific ideas and there were opportunities for them to fulfill their curiosity.



Figure 3. (Left) The weather station installed at the Ban Samkha village. (Right) The rainfall information is uploaded to a website accessible by students.

The Laptop Band

This activity involved students forming a band mixing the laptops with traditional Thai musical instruments. The idea emerged after a group of students became fascinated using the laptops to create music. They have discovered a way, through a program called Tam Tam, to turn the keyboard into a musical instrument. A parent who is a vocalist from a traditional Thai band saw what the students were doing and engaged them to sing along. The group then came up with an idea that the laptops can serve as instruments in the village’s band. Since the computer software could mimic many instruments, each laptop could play different sounds. This band (see Figure 4) became popular and they performed at many shows including a few in Bangkok.

From a learning perspective, the true value of this activity was revealed in the process of putting the band together. While tuning the local instruments to the laptops, the band discovered that the western musical interval is different from that of the traditional Thai instruments. That is,

depending on the type of music being played, the eight notes in an octave are divided differently (Miller T., Williams, S., 2008). This mismatch was initially frustrating and it was not possible to decide which side is “out of tune”. Both sounded “right” but they could not mix in harmony.

When the teachers discovered the cause and discussed it with the students, many students wondered how they could tune the sound on the laptop. This meant shifting the frequency of each key up or down. Although this process turned out to be too technical, the concept of sound frequency was widely discussed among the students and teachers. Although there was not an explicit attempt to teach students about the science involved nor was there any kind of assessment to prove what the students may have learned, there was no doubt that the students were highly engaged in the topic and collectively discovered something new. In the end, the band was able to identify a selection of Thai songs that were acceptable for the mixed band. Also, since the Thai instruments were tuned by ear, they were able to make some adjustments to compensate for the differences as well.

Because the laptop band became rather popular, the two other schools in this pilot program took on the idea and created their own version of the band. However, these later bands were different in two significant ways. First, original band emerged because of the existence of the traditional band. The later two were introduced mainly as a class activity. Thus, the original band in Ban Samkha was more authentic. Second, the songs selection of the later bands was mostly the same as those used at Ban Samkha. Thus, the miss match between the Thai and Western music intervals did not come up as an important issue for them.

Our intention of comparing the original and the later version of the laptop music activity is not to diminish the value of the later cases. The activity was adapted from its original context of a small rural school to an urban setting with a much larger class size. The activity was not a failure. In fact, feedback from students and teachers were highly positive. But the quality and authenticity of the activity were different from Ban Samkha. The differences observed of the same activity in different schools show how learning is tightly coupled to the local context at which it has taken place. Such learning activities do not transfer easily!



Figure 4. The Laptop Band integrated with traditional instruments.

Case Studies in Curriculum-Driven Learning Activities

Unlike community-oriented projects, the situation was drastically different when the learning environment was driven by the curriculum. The following shows examples of what took place when the learning activity becomes more school-like.

Modelling and Programming

Two months after the laptops were distributed to schools, a Thai-language programming platform was made available. The arrival of Scratch, a graphical programming environment for children (Resnick, M. et al., 2009), with a Thai interface created a significant difference in the kinds of projects student did with the laptops. Programming became a popular activity; being rated in the top three of the most used applications as reported by the teachers. Projects with

programming elements allowed for more interaction and better integration of rich media than those created by specialized programs like paint or a word processor. Scratch projects incorporate drawings, animations, pictures, and sound all of which can be given dynamic behaviors. Consider the following case study.

Khru Tukta, a sixth grade teacher, has been using maps to teach students, ages twelve, about geometry and other mathematical ideas for many years. One particular exercise is to ask student to draw a map showing the route from the school to their home. When this activity was first moved from paper-and-pencil (Figure 5 left) to the laptops, Khru Tukta appreciated the increase in students' engagement and participation. However, since the students initially used a paint program to draw the maps, the output was more or less the same as that done on paper (Figure 5 center). Thus, there were no significant intellectual benefits from the transition to the digital medium.

When students started to create projects with Scratch, however, she realized that her activity can now expand to cover a much larger range of activities and subjects. Students can record their voice to narrate the trip back home and add an animated character that moves along the path (Figure 5 right). Pictures taken from the laptop's built-in camera can be programmed to pop up showing important landmarks along the way. Such dynamic behaviors were not possible with paper-and-pencil. Thus, programming clearly enriched the map activity with more possibilities and creativity.



Figure 5. (Left) Maps drawn on paper. (Center) a digital map on the computer. (Right) Programming allowed students to enrich their maps with animated characters and story plots.

Rich Media and Storytelling

Storytelling is another popular learning activity observed in the pilot schools. It is common to see photo essays about family, local historic sites, weddings and other seasonal festivals. The activity fits well with what the teachers has already been doing, given that the Thai curriculum clearly dictates the development of language and communication skills. The teachers can also use the content of the story to assess the students understanding of a particular topic in the curriculum. In this case, the digital medium fits in nicely for the teacher by allowing an integration of rich media such as text, pictures, animations, videos, and sound recordings. Many teachers also find this activity more relaxing for them, especially for those who are less computer-savvy. With other kinds of activities, such as programming, there is a risk of the teacher being stuck and not being able to help students finish their work. But storytelling can go on even if all goes wrong with the technology.

Some teachers are able to go further and utilize the new possibilities to develop novel learning activities. For example, because students enjoy taking pictures with the laptop's built-in webcam and showing them to friends, Khru Srinuan in Ban Samkha School organized a photography fieldtrip along the nearby mountain. The assignment was for the students to take pictures of plants or flowers that they do not recognize in the forest as shown in Figure 6 (Left). They would then show the pictures to their friends and try to figure out what the plants were and write

descriptions for others to later see. Other observed examples include video assays showing indigenous medicine using captured video interviews, stage acting using the computer screen for props and making sound effects (Figure 6 center and right), and making animated electronic cards for teachers and friends during the New Year's celebration.



Figure 6. (Left) Photography with laptops. (Center and right) using laptops as props and a sound source for plays.

Information Inquiry

It should not be a surprise that using Internet-connected laptops to search for information is an activity used by all the teachers. It fits well as an extension to the existing practice of the classroom. However, it requires a great deal of creativity to prevent this use from becoming over-taken by the traditional school routine. There have been complaints from some teachers saying that searching the web takes too much time and is a distraction from what the students need to learn. Consider the following case study.

A teacher requested the class to describe the internal organs of a typical fish. Instead of just looking this up in a textbook, the teacher asked students to search the Internet as well. Since the activity was assigned without the students' participation and it did not leave space for much creativity, students ended up with similar pictures and descriptions mostly from the same websites. In this case, searching the Internet meant extra work and made it difficult to complete lessons as planned. Difficulties connecting the laptops to the internet and other technical issues made it even worse. In this situation, teachers perceive the laptops as a distraction.

On the other hand, the response is positive for teachers who engaged students in creative open-ended projects and gave students more freedom to express themselves. For instance, Khru Jiraporn, a fourth grade teacher, engaged her students in finding out the nutrients contained in the food the students like to eat in a day. Then they would try to create their own healthy diet. Jiraporn passionately described how her students were able to learn much more about the given topic than that described in the school curriculum. "With the Internet, the scope of what the students could learn is equal to adults". The diversity among groups led them to discover different aspects of the topic and the information spreads quickly among the students when something "new" was found. "Students are enthusiastic doing their work on the laptop and you can really see their desire to produce good work".

Khru Jiraporn uses curriculum mapping to track students' progress, which alleviates her from the traditional rote teaching method. She admits that tracking students individually can take a lot of effort but the result is rewarding.

Outside of the classroom, accessing the Internet is a major attraction to the students. There are reports from all the participating schools of students who would "load" their laptops with web content before going home. The web pages could contain information related to homework. Or they could contain non-school related content. For example, students at Ban Samkha would load soap opera manuscripts to read at home. These manuscripts are common in Thai newspapers

and give out the plot of episodes yet to be aired on television. Some students in Ban Samkha even come to the school at night to connect to the school's network.

Reflection:

This work has showed empirical examples from a longitudinal study of how learning with one-to-one laptop can take place and how they could differ significantly depending on the purpose of the learning activity. The following section attempts to synthesize the important foundations that allowed the activities to take place.

Innovation as a Developmental Process

From our experience working with the two urban schools, it was clear that the schools' primary responsibility is to deliver the content defined in the national curriculum. Any intervention or innovation must first address how this ultimate responsibility can still be fulfilled. Curriculum mapping has been the most commonly used technique to deal with this issue. Teachers would evaluate students' projects and map what was learned to items in the curriculum. This method satisfied the school system while giving room for project-based activities. It is important to note that teachers do not see this as a compromise. Instead, they usually promote this practice as a standard procedure. Although Papert probably would not reject subject guidance altogether, but following a single strict curriculum would severely contradict with his notion of epistemological pluralism (Papert, 1992).

We believe this situation is an example of how assimilation is taking place in the schools. Curriculum mapping is a good example of how the new is assimilated into the old without requiring a major change to the system's foundation. This is a kind of assimilation less severe than many other cases where the innovation is transformed entirely to keep every aspect of the traditional schooling the same. The two schools have changed in many ways (i.e. long-term projects are possible), but some key aspects of traditional schooling are still kept the same. Thus, from a Papert's perspective, these schools are well in their developmental stages. It is essential, though, that they continue to evolve. Otherwise there is a danger of becoming too comfortable with the current practices that they may become stuck in an artificial stable state. For example, even though curriculum-mapping allows for project-based activities, project ideas often stem from the need to cover a certain topic in the curriculum more than the students' interests. Therefore, all parties involved must work together to keep pushing things forward in a positive direction.

The observations of community-oriented activities show a drastically different situation. In Ban Samkha, since the activities were mostly done outside of school and were integrated into real issues of the community, their origins were not driven by the curriculum. Learning that took place in the case studies were authentic and meaningful to the students and the laptops played an essential role. As a result, these projects have made Ban Samkha a model school and they have been well publicized in recent years. Ironically, there has recently been more emphasis on schooling in the traditional sense at Ban Samkha. Teachers have expressed that their students do not perform well enough in the national tests. They feel that the school should do well both in terms of community projects and test scores. In a way, becoming a model school has held them back due to the fear of not fulfilling the expectations of the current educational system. It is a situation where the existing schooling system can oppress an innovation even after the innovation has become successful. From a Piagetian's perspective, Ban Samkha is, too, in a developmental stage. Therefore, the most important thing for the school is not to "get it right", but to continue to evolve and move forward in their thinking.

Understanding Progress: A Holistic Perspective

The developmental process discussed above is not governed by a single entity. The school teacher, the school institution, the technology alone cannot be held responsible in isolation. Laptops will not make a difference unless there is proper facilitation from teachers. But teachers will lose their jobs if they do not fulfil their requirements no matter how convinced they are about Constructionism. School administrators may want to give teachers more flexibility but they have to stay within the limits given by the school's own superiors. We will always reach a deadlock unless we look at the system holistically. This work has presented a snapshot of schools in their developmental process. Their characteristics are defined by the following factors.

1. The Technology. One-to-One laptops have clearly created new possibilities for learning. This work has shown in situ examples of how learning activities can move beyond the limitations of paper-and-pencil. There is no question that a learning environment where every child has an internet-connected laptop brings about new ways of reaching content, communicating with peers, and expression through interactive rich media.

2. The People. Teachers hold the ultimate authority in the classroom. Developing learning activities like those shown in this paper requires the willingness and leadership of teachers. This work has found that teachers are capable of adapting to make the most of the new learning opportunities. However, teachers also have many questions and doubts. Teacher development takes more than teacher training. They need, among others, examples and guidelines, opportunities to experiment, and places to reflect upon the lessons learned. The process is developmental and happens over a long time period.

Students also create an impact on the learning process as well. Students' enthusiasm with technology and the increased interest in learning has inspired many teachers. For example, students' overwhelming interest in photography and programming have influenced the kinds of projects that teachers later chose to conduct. This force resembles the kind of irresistible outpour from learners that Papert calls "Child Power" (Papert, 1993).

3. The Institution. The School's support for flexible class organization and student assessment was essential for the progression of this work. If there was no support from the school managers, expecting teachers to innovate while keeping everything else constant would be unrealistic. Since schools are assessed by the municipal office, which is in turn governed by the Ministry of Education, schools do not always have the freedom to take action the way they want. In this work, the schools were able to justify their actions based on the fact that this is a pilot project working with a relatively small number of classrooms. Ban Samkha is a model school and, thus, now have the privilege to be unique. The situation would be different, and possibly much harder, for larger implementations of one-to-one computing.

Summary

Does this work with one-to-one computing illustrate a kind of end-point that Papert has envisioned about the future of learning? Not even close. However, we believe that the case studies provide a valuable example of the process of getting there. We have shown concrete examples of how one-to-one laptops can lead to novel learning activities both in a school and a community setting. Although these activities are still influenced by the existing school paradigm, we have presented a holistic view of the progresses that have taken place.

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