After months of preparation, the time had finally come to start my research fieldwork. Refreshed from a two-week vacation with my family, I set off from Chiangmai, my hometown, to Lumpang province. I had organized a five-week after-school learning activity with a group of eighth-graders at a public school, Tongtip, located in Mae-Ta district of Lumpang province. I went to Lumpang one day before the activity began to make sure I had enough preparation time with Dr. Suchin Petcharugsa, my main coordinator of this learning activity and director of the Constructionism Lab at the Northern Region Non-Formal Education Center. Unfortunately, Dr. Suchin was away for the day. However, I talked to him on the phone and he said everything was organized. He arranged three researchers, Nung, Aek, and Ore, to help me throughout the five-week activity.
I went to Tongtip School in the afternoon to meet with the principal and Ajarn Sawat, my coordinator at the school. The principle gave me a warm welcome and confirmed that they were excited to host this activity. Their motivation is driven primarily from the need to experiment how technology could be used to support the new education act (as described in chapter 3). Originally, more than twenty students wanted to join this activity. However, we decided to keep the group small, which would allow closer observation of each student. So, we reduced the number to ten (though by the second week, three more students joined).

The Suksaphat foundation supported a lab with fifteen computers in early 2000, some of which are networked and could connect to the Internet through a modem. Tongtip had some power drop problems, which had already destroyed power supplies in some computers.
Luckily, Ajarn Sawat knows how to fix and maintain computers. He managed to keep most computers running throughout the five-week activity.

### 4.1 The First Day

It was an exciting day for everyone. I arrived at Tong-Tip school around 15:30 and found that all ten students were already waiting. They started to giggle as I walked in. I knew some of the students before and have even been in e-mail contact with one of them. The students were not sure what they would be doing in the coming weeks. I did not want to give them a feeling that they were in a school class or a special training program, which I felt was the general impression of the students. So, I told the students that this activity is an after school club. They should feel comfortable to come and leave as they wish. They could work individually or in groups. They could work inside or outside the computer lab as they want. My goal was to make the environment as casual and relaxed as possible. I can, then, get to know the students, see what they had already done, and start developing project ideas from there. Hence, I was building a convivial learning environment from the very beginning. In order to reach into students’ potentials, it was important that students did not feel obliged to join or to do a specific task imposed by the teacher. This is the reason why I made the Sarnfun project an after school activity and did not make it compulsory.

![Figure 4-3: Lego Mindstorms.](image)

This commercial product from Lego allows children to design and build actual Robots. With a small programmable computer called the RCX brick, children can process inputs from various sensors and drive output devices such as motors, lights, or speakers responsively.
However, I felt that the students were not sure what I meant. They were waiting for me to do or teach something. I soon realized that I had to start working on projects right away. I had a few Lego Mindstorms sets with me. So, I opened the boxes and invited students to join me. Meanwhile, I made sure I mentioned to them that not everyone had to stay. Students who are not interested in Lego are free to work on other projects. Since it was their first experience with Lego Mindstorms, all the students were interested and wound up playing with Lego. Everyone enjoyed making cars, adding motors, and making the cars run. I took that opportunity to talk to students and to get to know them better. The first day was a success! We were able to get past the traditional ways of teaching and learning.

4.2 Ideas for Children’s Day

While we were playing with Lego, I was reminded that the coming weekend was Thailand’s children’s day. I noticed that the students were excited about it and were looking forward to the school’s children’s day festival on Friday. There would be no classes. Instead, there would be games and sports for the students to play. I felt it would be a great event for which students could make projects. So, on the second day, I suggested to the students that we could build something for children’s day, something
that other students could enjoy. The students liked the idea. After a short discussion, we concluded that we would divide into three teams, each making a game. The students formed groups and went off to talk among themselves about projects they wanted to do. I decided to make my own game as well. I wanted the students to see that I was not there just as a teacher or supervisor. It would also allow me to demonstrate new tools that I had. It might capture a few students’ interest and lead to new projects. The practice of a teacher working on his or her own project together with the students also sets a different tone to the learning environment.

The first group had two members. They decided to build a Lego car and a controller for it. Lek, 14, said she saw other junior students wanting to play with the Lego car she built the day before. So, she wanted to make a better car and give everybody a chance to try. I happily agreed and started to ask about what features she and Tan, her partner, wanted the car to have and how they would implement the ideas. The first functionality they wanted was obviously to control the car so that it could move forward, backward, and turn.

The second group had six members. Although the group seemed too large and I had suggested that they break into two groups, they insisted on staying together. After their meeting, the group decided to create a Dance game, which would imitate a, at that time, famous arcade
game called “Dance Dance Revolution” (Figure 4-4). The basic idea of this game is to make the player dance by stepping on floor mats following the sequence and rhythm seen on the screen.

I was not so sure whether making the dance game would be a feasible idea. Though the students were thinking of simplifying it by using the keyboard instead of the floor mat, the game still sounded too complex for them to finish within two days. However, they were determined. So, I did not say anything against it. Ore, one of the research assistants from Lumpang Constructionist Lab, offered to help me facilitate this project. I suggested to Ore that she should discuss with the students how to divide the program into smaller parts and, may be, try to simplify them. I was worried that they might lose their confidence if they could not get the game working on time.
Figure 4-4: Dance Dance Revolution.
This arcade game was extremely famous among teenagers. Driven by dance music, the player has to step on four different arrow mats following the sequence showed on the screen.

The final group had two male members: Non and Pan. They did not come up with any ideas at all. They felt left out, as they did not feel fit with neither the all-girls dance game group or the Lego car group. So, I offered them to help me with my game. They agreed, though without much motivation. I could see that they were not so excited about the whole children’s day idea.

4.2.1 Saving the Princess

Since I had to build my own game, I wanted to utilize the opportunity by making a project that uses a tool that the students have
not seen before. In this case, I wanted to use the Go-Go kit: a new tool that I had developed. The Go-Go kit basically provides a channel for Microworlds to sense and control the environment through the Lego Mindstorms’s RCX brick. The general idea was to use my project as a mean to introduce the tool to the students.

To make the game interesting for young children, I made up a story to go with it. The player would imagine himself as a prince who has to save the princess from an evil king. The princess awaits the prince in a cage that is hanging on a piece of rope. The evil king could destroy the cage by burning the rope and let the cage fall to the ground. A fire would gradually move upwards until it reaches the rope. The prince has to stop this fire before the princess falls.

With the general story set, I initially planned to create the prince as a character in a computer game created with Microworlds programming environment. The princess, on the other hand, would be represented by a doll hanging on a piece of rope in the physical world. The player has to win the computer game in order to save the princess. A candle controlled by a Lego mechanism would, if not stopped by the prince, eventually burn the rope and the princess would not survive. The two parts would be integrated with the Go-Go kit.
4.2.2 A New Game Emerged

Non and Pan were not so impressed by my game idea. I was not surprised, as the game was totally my idea and they did not have a clue how the game could be implemented. However, they wanted to contribute to the children’s day activity. So, they offered to help me design and build the Lego mechanism that would lift the candle.

Just when I was about to program the Microworlds game, Lek who had overheard the details of my project, came up with an alternative game suggestion. Lek thinks the game would be much more interesting if we used her Lego car to represent the prince. That is, the players would maneuver the Lego car and trigger something to stop the fire and save the princess. I remember myself being so excited about the idea, as it truly made more sense to everyone. Lek’s idea would put her Lego car into a story context. The game would suddenly have a character and a mission for the players to accomplish. It would also lead to interesting and open-ended questions, as we would need to think about how the car could stop the fire and what would indicate that the princess has been saved. I was happy with this new game idea, though it meant I would lose my opportunity to use the Go-Go kit altogether. But to me, getting students to suggest and work on their own ideas was more important. After all,
my focus is on student-driven projects not teacher-driven ones.

After spending some time discussing ideas about the final implementation of the game, we came up with the following plan:

- The Lego car would carry an RCX brick on it. The brick would constantly send an infrared (IR) signal as a "key" to stop the fire. Though the students have used infrared before (for example, in remote controls), this was the first time that the idea of using in IR signal to transmit data was demystified. The students were learning to use concepts that are usually exposed only to engineering students.

- A second RCX brick would control Non and Pan’s mechanism, which periodically raises the candle and would stop only when it receives the IR “Key” from the Lego car.

- The princess would be tied to a rope. The rope would be wounded through pulleys to a motor also controlled by the second RCX.

- When an IR "Key" is detected, the second RCX would stop the candle and lower the princess. The Lego car must catch her before she reaches the ground.
The first RCX in a Lego car would constantly send an IR signal (key) to stop the candle and lower the princess. The second RCX releases the princess when an IR key is received. Motor controls the movement of the candle. The candle will eventually burn the rope if not stopped in time.

Figure 4-7: The game plan
Lek and Tan were responsible for the Lego car, while Non and Pan were in charge of the mechanism necessary to control the movement of the candle.

4.2.3 Depression

Just when we were starting to make the game, I noticed that Tan had lost his interest with the Lego car. I was surprised because I remembered seeing him motivated during the first day. When I asked Tan how he was feeling, he told me he does not enjoy using Lego. He preferred to go back to programming. Although he still wanted to be part of the car project, he kept his distance. Lek remained active with the construction of the Lego car.

Non and Pan were not motivated as well. At that point, they were doing the project just for the sake of having something to do. The fact that they were not familiar with Lego made the situation worse. On top of that, thinking about
how to implement the candle mechanism was an open-ended question. There were no instructions to follow. It was clear to me that they did not know how to tackle the problem. I tried to make them feel more comfortable by helping them divide the project into sub-tasks. I introduced them to Lego gears and how they could gear-up or gear-down the motors to increase or decrease rotation speed. I hoped these ideas would give them schemes for building the structure. However, both of them were very passive and quiet. At that point, I was not sure how successful the project would be. Three out of four students were not motivated. The situation was awkward.

### 4.2.4 Recovery

The twist came when all the game pieces started to work together. Non and Pan programmed an RCX brick to periodically turn on a motor, which lifts a candle upwards slowly. Lek tested her car and figured out how much time the player should have before the candle burns the rope. Everything started to come together. I was surprised how Non and Pan changed. Now, they want to make their project work! They started to talk and respond to my questions and ideas. When their Lego mechanism broke, they created a more stable motor and gear structure. The environment changed. Ajarn Wiratchai, the school’s science teacher, who was helping me that day, initially did not want to stay later than six o’clock. But in the end, he also got interested
and stayed with us until the very end (around seven). I was both amazed and relieved by the attitudinal change.

### 4.2.5 Showtime: The children’s day

On children’s day, I arrived at the school early in the morning. The students were already waiting for me. The festival was held at the school’s primary education department located half a kilometer away. We took two computers and the Lego structures we had made over to the festival. The teachers arranged a space in a cafeteria for us to show our work. The setup process was fun and every student contributed.

Non and Pan had arranged a wooden desk for their Lego game. We actually did not have time the day before to test the whole system. So, everyone was anxious to see whether everything would function as planned. Non hammered a nail to the desk (point 1 in figure 4-9). Pan taped the motors in place (point 2 and 3). They both continued working quickly on the remaining parts. We got all the elements in place and ready for testing within half an hour. Lek had some problems with her RCX and discovered that the batteries’ power were low. Luckily, we had some extras for her. We reprogrammed the RCXs and ran the first test.
After the test, we discovered that two crucial parts were not functioning correctly. First, the rope that was supporting the candle was winding on the two axels differently (point 3 in figure 4-9), causing one side to move up faster than the other. As a result, the candle tilted while moving upwards and would eventually burn its own supporting ropes. The other problem was that the candle was not aligned to the rope it was supposed to burn. Thus, even if the candle had made its way up to the top, it would not burn anything. With these two bugs, we had a game in which the evil king not only fails to kill the princess but also tends to burn himself down.
As time was critical, all three students dived in and tried to solve the problems. I jumped in to help them too. For me, it was a wonderful time. The situation was totally different from when the group started working on the project. Now, the project had real meaning to them. Non and Pan are not doing the project just to have something to do anymore. The questions and problems are still open ended, but that did not matter any longer. The way they were thinking about the problems was probably as intuitive and spontaneous as the way they would think about other issues in their daily lives.

Figure 4-11: Fixing the bug.

(Left) Pan, Lek, Non, and Dr. Suchin (From left to right respectively) thinking of how to solve the problems the game was facing. (Right) Pan adjusting the motors.
After tweaking the system for sometime, we finally got the game to reasonably function. So, we asked the schoolteachers to make an announcement inviting children to come and play. It did not take long before the cafeteria was filled with curious children. Since it was not obvious how the game works, Lek had to tell the story and explain the rules to the crowd. She was nervous about this unexpected task but she managed to do a good job. Speaking in public is a not a small act for students in the Thai culture. Thus, it was a significant accomplishment for Lek that day. Everyone enjoyed the game, including a few schoolteachers who were there.

Figure 4-12: A successful game
Children gathered around the game area hoping to get a try. The game was easy to play and had an interesting story, which led to its success.
4.2.6 The Dance Game

The dance game was a great success as well. The game was already finished the day before the festival. I was completely wrong to think the game was too complex. I was thinking in traditional computer science terms, where every problem should be implemented with the best data structure and algorithm. Instead, the students (of course, with Ore’s support) had much simpler ways to implement what they wanted while maintaining a joyful game experience. For example, the most difficult aspect of the game to me was the synchronization of the game play and the music. I could not imagine how the students could ever implement this function. It would be a challenging task even for a fluent computer programmer. However, the student made the game work without caring about this synchronization at all. That is, the key sequence a player has to press had no relation with the music what so ever. The game was still perfectly playable and was indeed enjoyable. The mindset I had from my computer science experience blinded me completely from thinking differently about how problems could be solved and how some problems are, in fact, not problems at all.
4.2.7 Reflection

From the number participants we had and from the laughter of the audience, it was clear that everybody enjoyed the games. Though there were some difficult moments, all turned out well in the end. This first week alone reflected at least three important aspects of the convivial learning framework. Ironically, they all come from cases where students felt unhappy with what they were doing.

A. First Reaction from the Students

When implementing a new learning environment, one of the first difficulties is what to do on day one. In my case, though I described to the students how the format of the learning activity would be, the students simply did not know what to do. Here, there is a parallel with the educational act that defines how the learning environment should be, but schools were stuck not knowing how to start implementing the new learning environment.

The case study that I have presented suggests that there has to be a context or a goal built concretely enough to motivate the changes to take place. My first day in Tongtip School was a success because we played with Lego. The students were new to Lego. Thus, students’ motivation that day was to fulfill their curiosity of the new tool. However, this kind of motivation
fades away quickly. It is similar to the case where a child gets a new toy. If there is no other motivation added to the use of that toy, the toy could quickly becomes boring. Based on the constructionist approach, developing projects is, in this context, a mean to sustain learners’ motivation. Construction tools are beneficial in this sense, as they support a wide range of project ideas.

Another source of learners’ motivation is context for which the constructed artifact would be used. In my case, students were motivated to build a game for the children’s day festival. This motivation was what kept that learning environment going. Combining this motivation with the project that the students developed, the students were sufficiently engaged in the activities of the new learning environment.

It was clear that by constructing artifacts (the Lego mechanism to lift the candle) and putting them into a meaningful context (children’s day festival), Non and Pan were able to eventually immerse themselves in the project. Non and Pan’s example evidently proves that a constructionist approach is preferred in an environment promoting conviviality.
B. Source of Authority: An Equilibrium

I have shown many examples of how I changed the way I was thinking or planning about projects as new (and sometimes conflicting) ideas emerge from the students. It clearly shows how I value students’ ideas. I sacrificed the chance for me to introduce the Go-Go kit for Lek to use her Lego car as part of the game, I respected the dance game group’s decision not to divide into a smaller group, I let the dance game group continue working on the game even though I was not sure whether it was a feasible game to build, and I respected Tan’s decision not to work with Lego. These are all practical examples of emergent design. When we emphasize on reaching into each learner’s potentialities to make the most of his or her energy and imagination, it is not possible to maintain a system that imposes learners with predefined activities or with teacher centric decisions.

However, an emergent environment does not mean everything goes. I had my own integrity of what was happening as well. When the prince game did not work properly on the children’s day, my role changed. I became much more active, less opened to students self exploration, as we needed the project to work. I was instructing how gears work to Non and Pan in a way similar to the teacher-teaching approach. However, the instruction was context driven to supply what was needed.
These examples show how conviviality defines the equilibrium between the traditional practice in schools and its extreme opposite. For many people, when they are exposed to ideas of alternative education, the new education has to avoid everything that happens in the old school. This is the case that John Dewey calls an Either-Or philosophy [Dewey, 1938]. During the time when I was working with project Lighthouse before coming to MIT, I have experienced situations where people would say teachers must not interfere with the students’ learning activity, as it is good if the child is having difficulties because they are learning how to cope with such situations. To some degree this argument is true, but not to an extreme. Sometimes we swing back from the traditional school so much that we become too anti-schooling.

An example of the equilibrium is how Non and Pan’s learning experience developed from an idea that did not belong to them. On one hand, I would prefer projects that come from students’ own ideas. On the other hand, I could not leave them alone until they came up with their own ideas. Given the situation where neither Non or Pan were familiar with the tools and the learning environment, I made a decision to push them forward with my project idea. But while the idea was mine, the type of activity remained open ended. I did not tell them exactly how to build the Lego mechanism. In fact, I was not sure myself how to make the structure work. I introduced them to ideas of using gears, pulleys,
and motors that I believe would be useful for them. But, it remained Non and Pan’s project to make the mechanism work.

**C. Tan’s Resistant to Lego**

Tan, who stopped working on the Lego car after the second day, told me that he does not like building physical structures. “Lego is not my thing,” he said. He prefers programming. I told him that it would be okay for him not to work with Lego if he is not interested. But, one can argue that Tan avoids things that he does not like, which is not the way things are in real life. I agree with this argument in some ways. It would have been better if Tan had not left the project and if he had helped Lek to finish the Lego car. However, forcing Tan to work on the project would definitely have been a mistake. The little more work gained would come at the expense of Tan’s personal freedom and my peer relationship with Tan. Thus, it would not lead to a convivial learning environment. This is a dynamic tension that was mutually irresolvable. However, later on when Tan works with Visual Basic projects, it would become evident that supporting Tan’s personal preference is a preferred choice.
4.3 An Introduction to Electronics

As we started the second week, I focused on developing new project ideas. One strategy I used was to introduce new tools that could lead to new projects areas. I was interested in using electronics to build sensors to control external devices (e.g. light switches). The existing RCX brick serves well as a processing unit, but it has been used mostly with projects that involve robots, cars, and a few other types of toys. The input-output devices are limited to the ones provided with the Mindstorms set. I wanted to extend the scope of possible projects. The following is a summary of the key ideas that I had:

- Use the RCX brick as a general computer for projects that are not just related to Lego construction (e.g. robot, car).
- Work on projects that involve thinking about making one’s own sensor.
- Introduce new output devices. I focused on attaching the RCX bricks to relays (Figure 4-13). Relays open up a wide range of projects, as they can turn on or off any high voltage electrical device.

I announced to the students that I would demonstrate a new tool and those who are interested could come and look. I did not force all students to come, as I knew not all of them
would be interested. However, all students decided to join the session. I started by showing them a basic LED circuit using a 9V battery. The circuit consists of an LED and a resistor. Then, I replaced the resistor with a potentiometer (a variable resistor). I showed them how light intensity of the LED changed when I altered the resistance. At this point, a few students dug out the components from the toolbox and replicated my circuit. I, then, replaced the 9V battery with the RCX. I programmed it to toggle the on-off state of the output port every one second. This program made the LED blink. Subsequently, I introduced the relay and talked about how it can control lights bulbs, water pumps, and other electrical devices. I drew the necessary circuit on the blackboard and started to use electronics symbols and vocabularies. The intention was to create a language for the students to talk about circuits. The session took about half an hour. Some students continued playing with the circuits and some went back to Microworlds.
I introduced simple electronic circuits to students. We drew schematics of the circuits that we made. Quite remarkably, the students started to use electronics terms intuitively.

The next day, I discovered that only three students (Lek, Non, and Khomphet) wanted to work with electronics. Though I had hoped for more, three were sufficient to start on a project. We talked about projects ideas. I knew that most students live in an agricultural community. So, I assumed that students would be interested in projects that related to their farms or crops. Thus, if our discussion leads to some interesting issues or problems that they or their parents were having, it could provide an ideal area in which to develop projects using sensors and electronics. The projects would be engaging, contextualized, and beneficial to both students themselves and to their community. Though this assumption was not totally wrong, I learned that my assumption did not quite match the reality.
4.3.1 A Disappointing Project

After spending some time with the students, I realized that the conversation about agricultural projects was not going so well. I did not know much about what crops or farms they had at home and the students did not know what to say about them. Talking about how to use the RCX and sensors with agricultural problems seemed so abstract and alienating to them. I realized that it was never the students’ role to suggest ideas about agriculture to their parents. Thus, the situation was difficult because I was trying to suggest ideas that not only go against the school culture but the local culture as well. After some time, the students proposed that they want to work on a door alarm system. They wanted to monitor the computer lab’s entrance so that when someone would try to break in, an alarm would go off.

I did not like this idea. Compared to what I was expecting, the door alarm project sounded so uninteresting to me. It seemed like a typical school project; A project that is totally unrelated to the students’ lives. Why would they want such a system? The project would never find a practical use anywhere. I tried to broaden the students’ ideas, but they felt most comfortable with the door alarm project. I did not want to push them too hard. So, I agreed with the idea. I took the project on as a short-term experiment that would help the students develop their
fluency with the tools. Then, hopefully they would move quickly on to something else.

4.3.2 Planning the project

We started the project on the next day by talking about features that the students wanted to include in the alarm system. I asked them what would happen when the door opened. I started to feel a tension in the conversation. My presence made the students feel uncomfortable. They were extremely quiet and passive. They eventually came up with a few ideas, but the conversation was more like “the teacher asks and the student answers” than a discussion. I felt I was intimidating them too much. So, I decided to

Figure 4-15: Group discussion

The students were extremely passive whenever I tried to talk about projects ideas. Though they were interested in the project, they felt uncomfortable thinking about open-ended questions like what features they want to have, who wants to do what, and how they should start. This is true specially when I was present in the conversation.
back off and leave them to discuss among themselves what they wanted to do.

I went back a little later to see how they were doing. Lek said she wanted to turn on the computer lab’s main lights when the door opened. I asked her how she was thinking of doing that. The students pointed to a power breaker. I went over to observe it and found that that switch was large and stiff. The students asked me whether they could use the relays to replace the switch. In this case, using relays was not practical, as the power level was too high and we did not want to mess up the school’s electrical capability.

I suggested that one possibility would be to create a Lego structure that would provide a pull strong enough to snap the switch\(^1\). It was an interesting challenge for the students. I tried to push the ideas forward by asking how they thought they could make sure that the Lego structure did not fail. Lek suggested that she could use a light sensor to detect the success of the Lego mechanism. If the light sensor did not detect an increase in light intensity, it would indicate that the light mechanism had failed. Then, I asked what they would do if the lights failed to turn on. That was when I felt the tension once again. The students were quiet and it almost seemed as if they felt guilty not being able to answer my question. I found it hard to

\(^1\) See [Resnick, et al, 1996] for a similar project done with Doors, light switches, and Lego construction.
engage them into a discussion when the only thing that mattered was what I said, not what we were thinking collectively. I did not blame them, as they grew up in an environment where teachers have the dominant authority over what matters.

Figure 4-16: Door Alarm System

This diagram shows how the system was designed. The RCX would monitor the door sensor. If someone would try to enter the room, The RCX would turn on the lights in the room by initiating motors that are arranged to snap the light breaker. The Light sensor then tells the RCX whether the first mechanism had failed or not. A backup system (consisting of a light bulb and an alarm) could be activated by triggering the relay.
I gave them some time to talk more among themselves. We finally came up with an idea of creating a backup alarm system that would turn on a light bulb and make a loud noise if the first Lego mechanism fails. The project turned out to be considerably more complex than I had anticipated. Everybody was satisfied with the ideas, including myself.

**4.3.3 Komphet**

Komphet was one of the students who worked on the door alarm project. He was not originally part of this learning activity. He only joined us in the second week. Komphet did not do well in school. In fact, I heard from a teacher that Komphet is the kind of student that teachers would give away grades just to help him get through school. He is an orphan and lives with his aunt in a house without electricity. When I visited his house and talked to his aunt, she complained about how badly Komphet performed in school. She did not think Komphet would be able to accomplish anything significant for his life. After he finishes middle school, Komphet’s aunt wants to send him to work at a friend’s garage in Bangkok city.
My experience with Komphet is totally different from what I heard from other people. I first met him at the children’s day festival. While we were setting up the Lego game, he was hanging around and was very interested in what we were trying to do. He was particularly interested in the Lego car. He saw that we were busy trying to setup the game, so he offered to help with other parts that we did not have time to handle. He also lined up the children and taught them how to control the car. He fixed the car when parts fell off. By the end of the day, it seemed as if the car belongs to him. To me, his enthusiasm made him one of the most outstanding students. I was surprised to hear the opposite opinion from the schoolteachers. I decided to invite him to our evening activities. Luckily, he did come. The door alarm project was his first project.

As we started to implement the door alarm system, Komphet chose to work on the
Lego mechanism that would lift the breaker switch. I recommended that he should start by playing with the motors. First, he tied a piece of rope to the rotating axle of a motor. He tied the other end of the rope to a dummy load. As the motor turned, it wound the rope around its axle, providing a lift. The single motor obviously did not provide enough force. He quickly chained three motors together. But, it was still not strong enough. At that point, I knew it was time to introduce him to gears to increase the force. In fact, I knew from the beginning that Komphet would need to use gears. However, instead of telling him from the beginning, I waited. I knew that the situation would be instructional by itself. I put two gears with different sizes together and showed him that when a smaller gear drives a larger gear, the larger gear will have more power. I added that it is the same idea used in bicycles. Almost instantly, he got the idea and was able to apply gears to his mechanism. I could tell he understood the idea by looking at how he optimized the gear ratios. He used Lego’s smallest gear to drive the largest gear. This arrangement produces the most power. After testing and trying for sometime, he finally came up with a design that he believed was strong enough. Here again, I did not see him the way other people had described him to me.
At the end of that day, all students gathered and talked about what they had accomplished. I invited Komphet to talk about his work. He was nervous and did not know how to react or what to say. But, I could see that he knew he has something good to show. Again, make in a presentation in front of people is a significant accomplishment in a Thai culture, as it does not happen very often. Komphet finally decided to talk. After the presentation, Komphet realized that his friends acknowledged his work and thought he did a wonderful job. It was a special moment for Komphet. A school-defined dumb kid receiving this kind of regard for his intellectual accomplishment is rare. Many of Komphet’s friends are perceived as clever students in the school. Though I do not know how Komphet really felt that day, I know he
views himself differently in terms of what he is capable of and what he feels able to accomplish.

### 4.3.4 Lek and Her Electronic Tool

While Komphet was working on the light breaker mechanism, Lek developed an RCX-controlled switch using the relays. She needed the switch to control the light bulb and the alarm used in their backup system. Lek had experimented a relay circuit before during the first electronic session that I gave. She started with the most obvious and simple design. That is, she inserted the relay in between the power outlet and the device she wanted to control (shown in figure 4-20). However, this design constrains the use of the relays to the particular device it is attached to. With small modifications we can build a general-purpose switch that can be used with any device. With an emphasis on developing tools in mind, I introduced the idea to Lek. With assistance from Nung, a research assistant, who has a background in electronics, Lek reconfigured the circuit by attaching the relay to an outlet. She mounted all the components on to a wooden board (figure 4-21). We wound up having a general-purpose computer controlled power switch. This switchboard turned out to be a very useful tool. It would be used later on with Lek’s fish farm project.

![Figure 4-20: Initial Relay Circuit Design](image1)
The relay lies between the power source and the controlled device.

![Figure 4-21: RCX controlled Switchboard](image2)
With small modifications to the first design, the circuit became a general-purpose tool. It can control any device that uses electricity.
The development of the switchboard reflects the methodology I used student’s projects to suggest the idea of making tools. Though my research emphasizes making tools, I did not tell students to do so directly. Instead, I kept the projects as diverse as possible and, while working together with the students, let the tool-construction idea emerge from the situation itself. When I introduced the switchboard idea to Lek, she saw how useful the switchboard would be. If I had tried to convince her right at the beginning, the idea would most likely have been too abstract for her to understand the value of the more general design. More over, the tool I suggested might not have been the switchboard, as it is difficult to foresee what an appropriate tool for a project will be. More examples of tools that were developed through this “emergent” methodology are discussed in other case studies throughout this chapter.

**4.3.5 Changing Plans**

Everything was going well until Komphet discovered that the power breaker did not actually control the lights in the computer lab. Instead, it controlled the power supply to the computers. The actual light-breaker was located two rooms away, and was much stiffer than the power supply switch. This fact was a nightmare for everyone. It was no longer feasible to turn off the main lights, which meant a redesign of the

*Figure 4-22: A new experience*

Lek enjoyed working with electronics partly because it involves learning new skills such as soldering, wire stripping, and copper plate etching.
whole project. At that point, the project was getting much attention from the schoolteachers and they wanted the group to finish the project in time for the Mae-Ta district science exhibition. The exhibition was only one week away. Everyone felt the pressure and redesigning the project was discouraging.

The redesigned system was much simpler than the original. We decided to use the relay-controlled lights and siren as the primary alarm. We did not feel the need for a backup system, as the relay mechanism would be reliable enough. I felt sorry for Komphet because his Lego mechanism would not be used anymore. However, we came up with a substitution idea for him. We decided to place a camera in the system that would take a picture of the burglar while he or she attempts to break in. Therefore, we needed a Lego mechanism to snap a picture. I was relieved thinking that this would keep Komphet happy.
### 4.3.6 A Mistake

Because time was tight and I was concerned that the Lego mechanism for the camera would be too complex for Komphet to develop all by himself, I decided to make a semi-functional model for him. I hoped that it would give him a solid start. I thought it would keep him from losing interest in the project. I was wrong. Having a pre-implemented model turned out to be alienating to Komphet. While I was showing him the model, he said to me “You made it because you know I can’t.” I was not sure whether it was a question or a statement, but it made me feel like I had been caught.

Komphet acknowledged the model, but he never treated it as his own work. Though the mechanism was not fully functional, Komphet did not want to improve it. He eventually abandoned it altogether. I soon realized my good intention was a mistake. I was offering too much help too soon. An open-ended design challenge had become a clearly defined task, a task like the ones Komphet receive everyday in school, like the ones that he fails so often. I do not claim that suggesting ideas is wrong. My approach might have worked for many other students. However, for Komphet what was important was not finding a solution or an easy way of doing things. Rather, it was the freedom and respect that he received to express himself as a capable person.
I admit that Komphet might have continued working with the model if I had spent more time encouraging him. I also admit that Komphet might have left simply because he was not interested in the camera mechanism, or because he felt the mechanism was too hard for him. However, I know for sure that Komphet would have spent more time on the project if I had worked together with him from scratch and treated him as a co-designer. I can still imagine myself suggesting that same design idea to him, but treating him as part of the team, and letting him decide what to do. It would have been a much better way to balance the source of authority needed for a convivial environment.

We finally finished the project and showed it at the science fair. It was an interesting project for visitors. Lek did most of the presentations. Komphet was still very shy, but he cared about the project enough to present it when Lek was not available.
4.4 Lek and Her Fish Farm

The science fair was the second milestone for Lek. The children’s day project and the door alarm system had given her fluency with the RCX brick and relays. I encouraged her to continue working in the same direction. Although she was rather tired of electronics and wanted to do something else for a change, she came up with another project idea. Lek wanted to use the RCX-controlled switchboard she previously made to control lights at her fish farm at home. In Thailand, it is common for fish farms to have black lights installed to attract insects, which fall into the water serving as food for the fish. Lek’s fish farm is located about one kilometer from her house. She or her parents have to travel to the fish farm at least twice a day to switch on the lights at dusk and switch it off two or three hours later when there are no more insects. Lek’s idea was to automate this task. It would not only save her family the trouble of going back and forth between the house and the fish farm, but would also keep them away from dangerous creatures like snakes and scorpions (ironically, Lek’s mother was stung by a scorpion on the day Lek started this project).
Lek’s idea was to attach a light sensor to the RCX brick and use it to automatically trigger the black light on and off at the appropriate time. She easily adapted the switchboard she previously built for the door-alarm project (See figure 4-25).

Figure 4-25: The switchboard adapted from the door alarm project.
A light sensor tells the RCX when to switch on the black light.
It may seem that this project is technically straightforward and one can easily imagine using a simple timer instead of the RCX. But, if we look beyond the technical aspects and the end product, we would see that Lek has experienced a learning environment that is profoundly different from her regular school days and it is an environment that I would call convivial. Lek had gradually gained fluency with her tools from the children’s day game and the door-alarm project. It was her fluency that led her to the fish farm project idea. The learning environment did not impose any purpose of using the tools to her. Rather, she felt empowered by the tools and was free to use them to enrich her environment according to her own taste. Lek learned to realize that she was not obliged to follow any kind of curriculum, but had the autonomy to define for herself what she saw as interesting and worthwhile for her to learn.
There was no test or scale that would define her as good or bad, better or worse than others. She defined her own success, which was accepted as her identity in her community. She recognized her ability to learn and realized that learning does not only mean being taught. She was confident that she could implement the fish farm project on her own. She was sure that she could overcome any obstacles she might encounter. After all, she knew she could always get the support from me later if she needed it. Lek’s fish farm project had a special ethical value, as the project was developed not only for the benefit of Lek herself, but also for her family. This project also changed the role of a child in her family. As I have mention before that it is not the child’s place to suggest ideas about how their parents could do things differently. But in this project, Lek actually worked on the project together with her father.
4.5 Tan’s Obsession with Visual Basic

After the children’s day festival, I asked Tan what he wanted to do. He instantly replied, as if he had been waiting for the question, that he wanted to learn how to make menus, tool bars, and other components that are familiar in most Windows programs. These are features that Microworlds cannot create. Tan had been using Microworlds for more than a year and he said he wanted to try something different. So, I decided to introduce him to Visual Basic. I chose Visual Basic because it would allow Tan to create the type of program that he wants without getting involved in the complexity of windows programming. Forms, menus, dialog boxes, and other common program components could be easily created.

Eak, a research assistant, volunteered to help Tan with Visual Basic. Eak had little experience with Visual Basic, but he was personally interested in it. Eak and Tan turned out to be good collaborating peers. They spent hours and hours learning together. Eak was a good computer hacker. His fluency with the web allowed him to search for websites and chat rooms that gave him information he needed. This was obviously an important skill that Tan could learn from Eak. Unfortunately, the Internet connection at Tong-Tip school was broken during
the time I was there. So, Eak could only show Tan how to use the search and chat rooms when they were at the Constructionism Lab in Lumpang City.

After a few days, Eak started to notice that Tan was losing his pace learning Visual Basic commands and features. Tan wanted the program to work but he did not care much about the necessary code. At that time, he was trying to build a web browser. He wanted to add buttons, toolbars, and other components that are common in a web browser. But, he was not fascinated with the code he had to write. He would come up with ideas and relied on Eak to give him instructions about how to implement them. This, of course, made Eak feel uncomfortable. Eak felt Tan was not learning anything. I felt the same way too, and we both tried to convince Tan to spend more time learning how to program. We gave him a Visual Basic manual, we showed him example codes, and we introduced him to the on-line help. But, Tan was not interested. It took me some time to realize that we were blinded to see what Tan really wanted to do.

After some reflection of what we though was going wrong with Tan. I realized that Tan was not really interested in Visual Basic programming. Rather, he was attracted by the ability to mimic and customize interfaces of programs he like. Tan enjoys chatting on-line with friends and strangers. So, he wanted to make his own version of an Internet chat
program and customize the look and function. Though he was excited, he did not really enjoy learning how to code it. Tan was interested to play a role of an architect more than an engineer. He could spend hours placing buttons and text boxes in the right place, creating his own color scheme, adding images to the background. But when it came to coding, he would just try to get it over with.

This was the second time that Tan refused to work on things that he did not like. The first time was when he moved away from using Lego. One may criticize Tan as being too selective and say that he needs to learn how to cope with things that he does not like. After all, we cannot do only what we like in real life. So, why leave him with this false attitude?

Maybe Tan does need to cope more with things that he does not like. But, it is very wrong to deprive him of what he enjoys. If I had forced him to learn Visual Basic programming, it would be alienating to him. By the time he learned all the necessary programming, if he ever did, he could have lost his excitement for the project altogether.

In the education system today, most learners do not get a chance to discover what they really like until they graduate. In Thailand, during the time I taught at the engineering department, I saw many of my students confused about what they wanted to do. Many realized after finishing their degree that they did not...
want to be an engineer at all. Some of them wound up working as an airhostess, an insurance salesman, or even a music instructor. In Tan’s case, he is, indeed, discovering what he likes. Of course, he needs to manage less interesting things in order to remain part of his community. But, we must be careful when we define the balance between the two. A convivial environment requires us to weight personal preference above external interventions.

4.5.1 Chat as a Tool

Tan’s self expression through the user interface design was pushed to the next level by the practice of making tools. I encouraged Tan to distribute his chat program to his friends. This idea not only motivated Tan to further design and decorate the interface, it created a feedback loop for Tan to reflect on his ideas as well.

Since Tan’s chat program was implemented with a true network library (TCP/IP socket), it allowed its users to send messages across the network. Given that many students like to use Internet chat, Tan’s program was interesting for them. Friends’ comments like “I think the yellow background is too bright,” “I like your flowers on the form,” “I don’t understand how to connect to my friend’s computer” helped Tan to reshape his design and provide ideas for
further development. He learned that too many colors on the screen actually made the program hard to use. His chat program initially supported only two users, but after receiving requests for more simultaneous users from his friends, Tan redesigned the interface to support multi-users (Fig 4-30). Many other designs were added and changed because of the feedback he received.

When creating a tool, it is implicitly assumed that many people will be using it. Therefore, the toolmaker needs to place special attention on making the tool usable to other people. The emphasis on tool construction is where ideas of “tools for conviviality” and “constructionist learning” become most fruitful.

Figure 4-30: User Interface Evolution

The first design (top) allowed two users to chat at the same time. Tan, motivated by friends’ demands, redesigned it to support unlimited simultaneous users (bottom).
4.6 Digital Video as a Convivial Tool

In addition to computers, Lego RCX and electronics devices, digital video was another appealing tool for students. There is something magical about digital cameras that capture children’s attention. No matter where I go, children are always excited when they see themselves or their friends on a screen. I remember one time when I was in Senegal with my colleagues, a little girl approached our group asking for money. When we started to show her our video cameras, the girl got so excited that she totally forgot about the money. The excitement was no different with the students at Tongtip. When I introduced them to the video camera, everyone wanted to get their hands on it. They would go around and shoot. Then, they would gather in front of the camera’s small monitor and laugh as they playback the video.

I made the video camera easily accessible to the students. I would leave it on a table together with the Lego pieces. The goal was to make the camera as accessible as possible so students would use it. Of course, this creates more risk of damaging the camera. Initially, I showed them some basic precautions (i.e. to always wear the shoulder straps) and my observation of how students use the camera suggests that they actually took good care of it.

Figure 4-31: The New Movie Director
Kib discovered how much she loves filming and directing movies through the free access of the camera and the encouragement she received.
Nothing much came out during the first week that the students had access to the camera. I was not expecting much to happen neither. My main goal was to allow the students to be acquainted with the camera. I also wanted a chance to see who used the camera the most and who would potentially be interested in doing a project with digital video. I knew it would be hard for students to come up with a project idea by themselves because they have not used a camera before and did not know the potentials. They would raise ideas of making movies, but they needed encouragement and support to actually pursue those thoughts. This situation provides another example of the need to balance the acquisition of knowledge and individual initiatives. While we could not expect students to develop the necessary skill by themselves, it does not mean teachers should take over the activity and develop projects for students. Conviviality asks for a balanced control in a different dimension. The following case demonstrates what I mean.
4.6.1 Kib’s Proverb Video Project

Kib was one of the students that joined the project without much idea what she wanted to do for a project. She started a game project in Microworlds. But she was only following what most of her friends were doing. However, I noticed that Kib would always give special attention to me when I talked about video. It was quite obvious that she wanted to show me that she was interested, but she was shy to do so directly. However, when I tried to talk to her one on one, she would feel nervous and back off. I realized that I needed to use a gentler approach.

A project with digital video started on the second week. Kib was working with two other students on a Thai proverb project. They were planning to implement a game in Microworlds. The general idea was that the player would have to match the proverb with its meaning. I saw this as a good opportunity to suggest a video project idea. I suggested to them that they could add a short video to their game demonstrating a situation that reflects the meaning of each proverb. Then, they could incorporate the video into their Microworlds project. The students were interested. So, I continued talking about how movie making involves script writing, directing, and editing. This opened up a whole new dimension to what they can do with video. Kib was most interested in the process. She was excited about writing scripts, and casting her
friends as character in her stories. We agreed to start shooting together on the next Saturday.

Here again, the development of the video project emerged from the current interest of the students combined with the insights of the facilitator. There are a couple reasons why my approach worked. First, the video idea connected to what the students were currently doing. Second, I knew Kib has interested in video. Finally, this was a group project. I learned earlier that Kib would feel uncomfortable talking one on one with me. So, having friends join the conversation made it easier for her. The project development is situation specific and often requires some patience from the facilitator (as they do not always succeed). In fact, Kib and her friends had rejected a video project I suggested to them earlier. The situation was very similar but it involved speaking English, as it was related to an English comprehension game. The students did not want to video themselves speaking English. So, that attempt did not work.

On that Saturday, all the students visited the Constructionist Lab in Lumpang city. Kib finalized her script with her friends and started to select the cast. By noon, they were ready to shoot. Kib both directed and shot the scenes herself. It was clear that Kib was not a shy person when she had the space to work with her friends. I let them work for a while and then stepped in. The instant playback capability of the digital camera allowed me to give suggestions on shooting locations and camera angles. It was a
fun process. The students would crowd around to see the video after each cut. By the end of the day, they already finished four proverbs. We hooked the video to a television and showed the video to all the students. Everybody had a big laugh.

I was more involved in the process during the second shoot. Having the first set of videos made it easy for me to point out some issues that could be improved. “I think the pacing was a bit too fast,” “you should make sure the volume is not too low,” “Did you noticed that the actors were not facing the camera?” were the type of comments I made. I saw that she acknowledged the comments, but was not quite sure what to do next. So, I decided to work closely with Kib on the first proverb she shot. I took the chance to talk about the editing process as well. I introduced her to the idea of cutting between shoots and switching between different camera angles. She learned that she could shoot the same scene many times, each with a different camera angle, and edit them into one single movie. After we finished the first movie, Kib continued with the project on her own. We watched the new movies at the end of the day and saw many improvements. Kib had a chance to digitize and edit some of her movies on a computer as well.