

Year 2 – Longitudinal Robotics Case Study

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Introduction

This basic research seeks to understand how children's engineering skills change over time. Secondly, I want to know how our K-6 robotics program influences students. Every year from kindergarten to grade 6, they are given the same task, which is to design and built a prototype (model) amusement park ride. Each year, they are offered crafts materials and an age appropriate LEGO™ kit. I transcribe their verbal output and take photographs of their creations along with selected video clips.

Major Findings – Year 2

All students primarily used LEGO™ this year; there were no all craft constructions. In kindergarten, there were 2 all craft constructions.

2 out of 9 students used the computer and motor even though all had learned it in class. Both were advanced students. This suggests that most students were not comfortable with using the computer to program robots yet or it was not a natural technique for them developmentally.

Even one advanced student frequently used tape to augment construction. Construction techniques were major challenge this year. I am seeing certain construction problems across grade levels that would benefit from some scaffolding. Fine motor skills, which were a major challenge for K students, was less of an issue for first graders.

First graders were not concerned with many adult notions like symmetry and consistency though they may notice and comment on them. They often were not able to project out that different design ideas that would not be stable or buildable.

Inherent building styles and personalities seem fairly well set and on a trajectory of some sort. I was surprised by this because I thought developmental gains and what was taught would be much more dominant. However, the use of LEGO™ at school may have influenced the choice of materials and had some effect on construction.

Self-talk was much less prominent for grade 1 students than K students.

Some students made up the ride as they went along, others had a clear idea and stuck to it, other had ideas but flexibly changed them as they went along.

As you can see from the photos of year 1 and year 2 projects, there was a big jump in sophistication from spring K to spring grade 1.

Summaries of Each Student

For each student, we first show the progression of creations from K to grade 1.

Boy 1

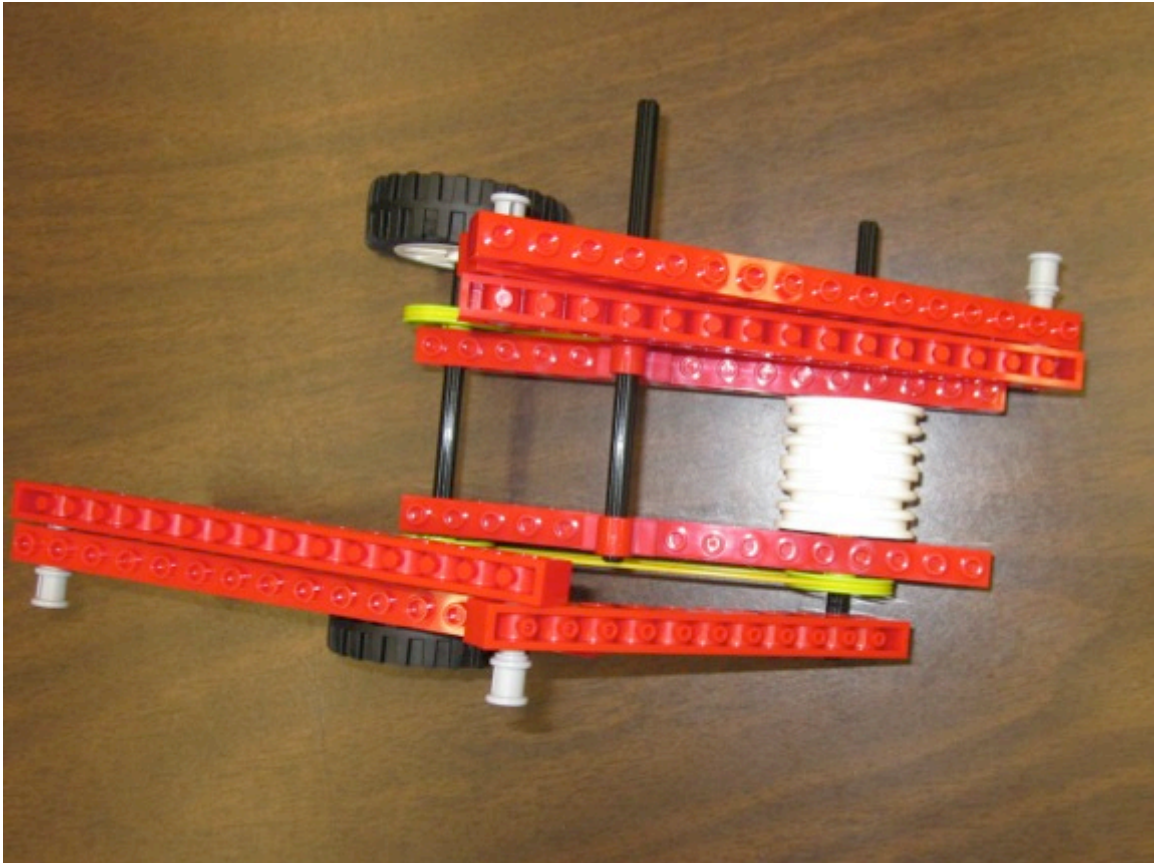


Figure 1 - Boy 1 - K - Ride With Crane

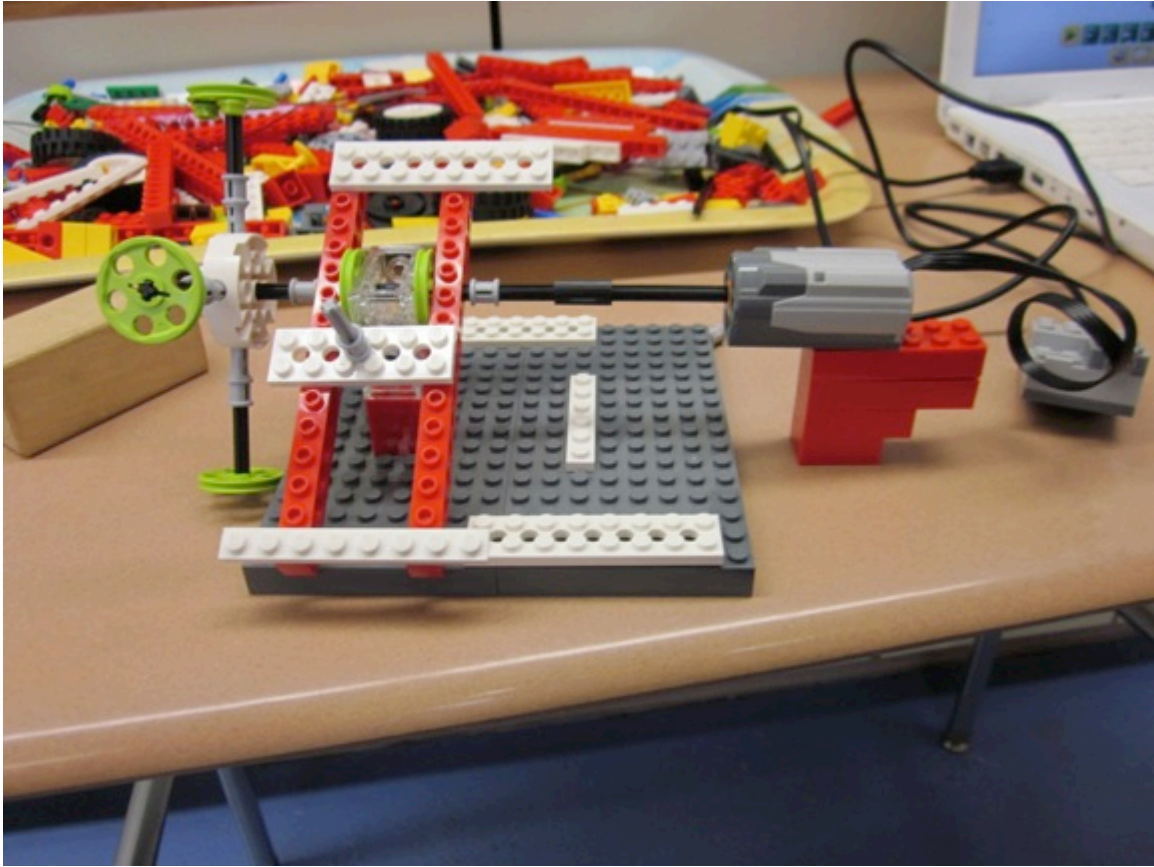


Figure 2 - Boy 1 - Grade 1 - Ferris Wheel

Boy 1 is a sophisticated LEGO builder at home. This transferred to this project though there were also some common building knowledge he did not have (fitting axles into star shaped holes, for example). He also was not able to project out that some of his techniques would not work but stated that, "There is only one way to find out." He was one of 2 students to use the computer and motor and was very comfortable doing so. He, once again, used a fairly sophisticated engineering self-talk as he went along. He was very comfortable with the engineering design process.

Boy 2



Figure 3 - Boy 2 - K - Line for Ride

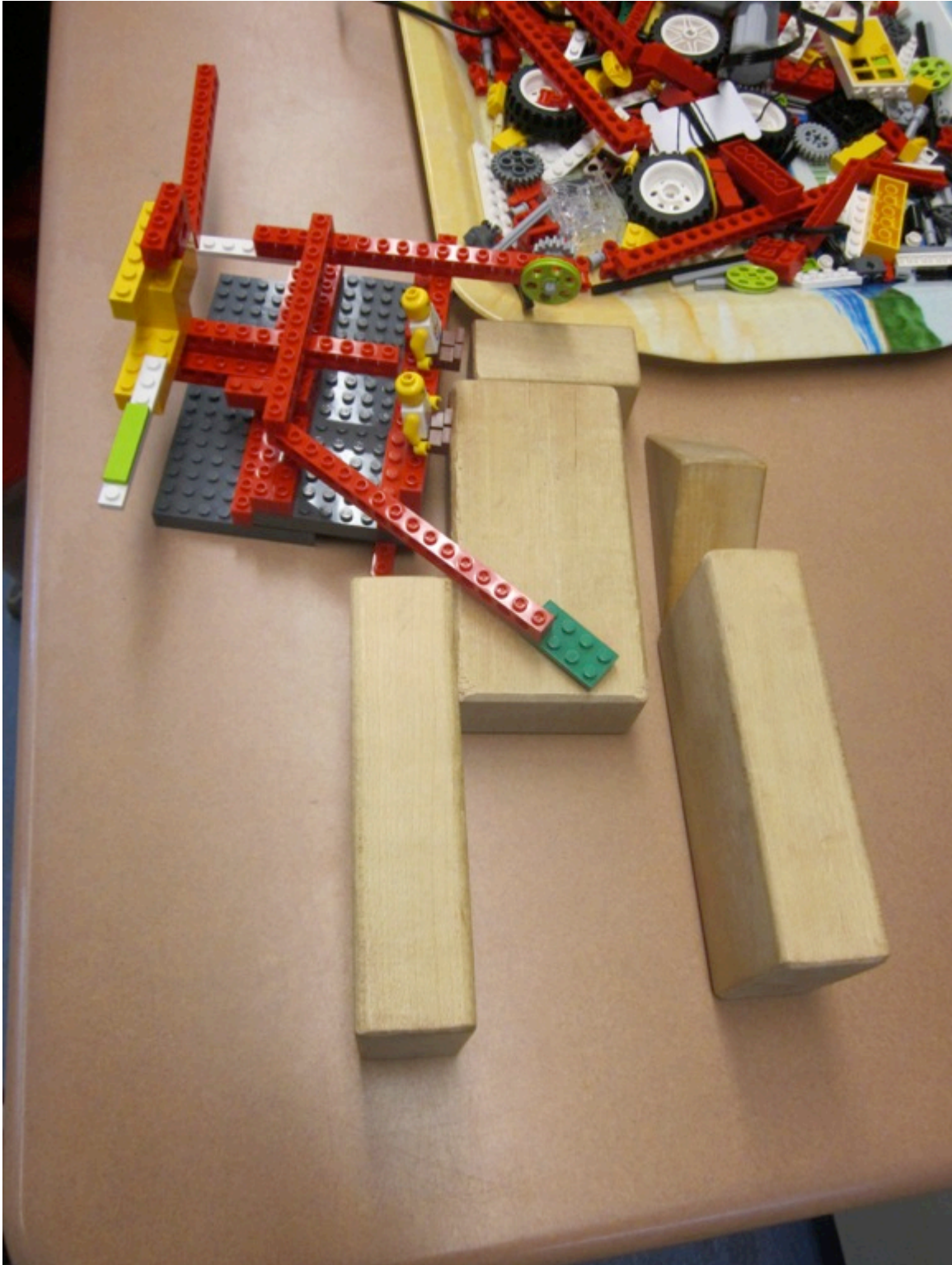


Figure 4 - Boy 2 - Grade 1 - Stair Ride

Boy 2 seemed to understand the directions much better this year and he made a much more sophisticated design. He did have continual issues with building and making stable structures though he did eventually work through some of them. His

ride was continually breaking. Again, we see a lack of concern/knowledge of conventional LEGO building techniques.

Interesting that he is trying to build with long attached pieces only affixed in one place. By second grade, they seem to be able to build much more stable structures without any particular instruction, which suggests some development progress - perhaps abstract thinking - at being able to project out what happens (causality).

Boy 3

Boy 3 is leaving the school so I did not observe him this year.

Boy 4

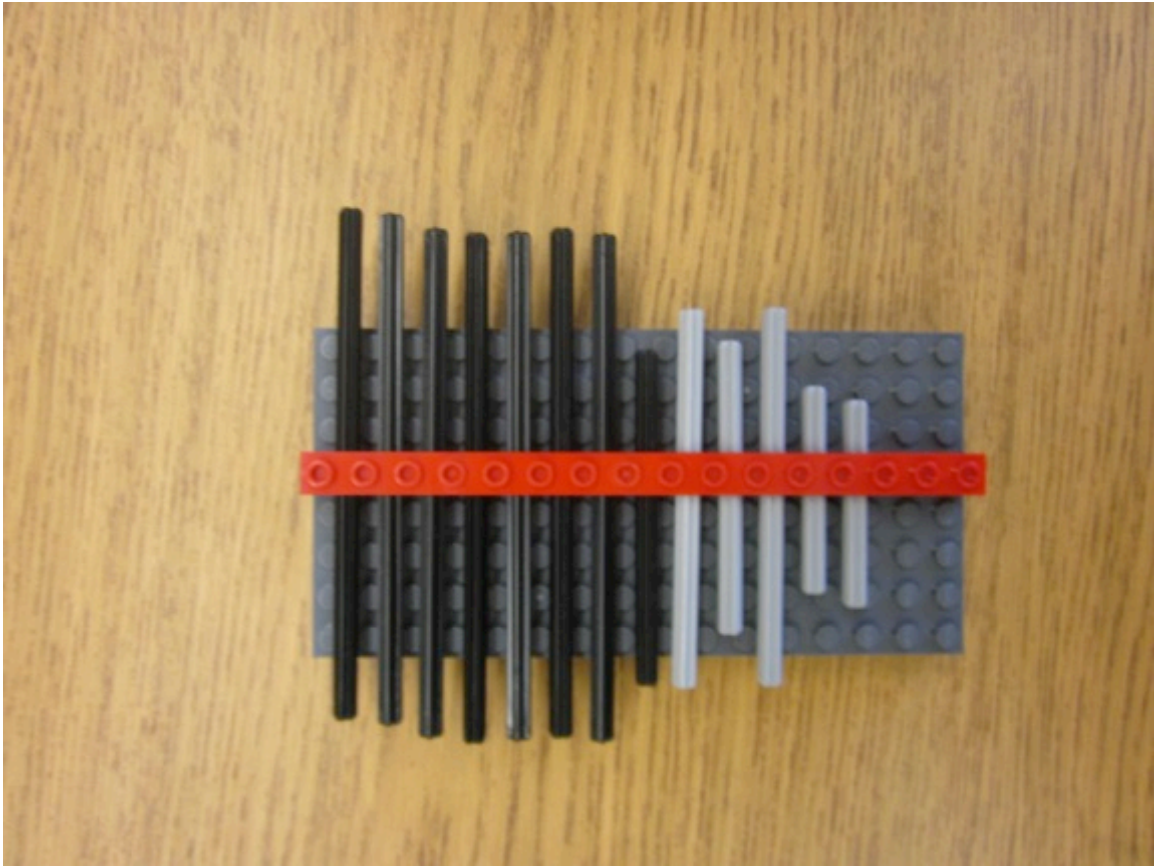


Figure 5 - Boy 4 - K - Sliding Ride

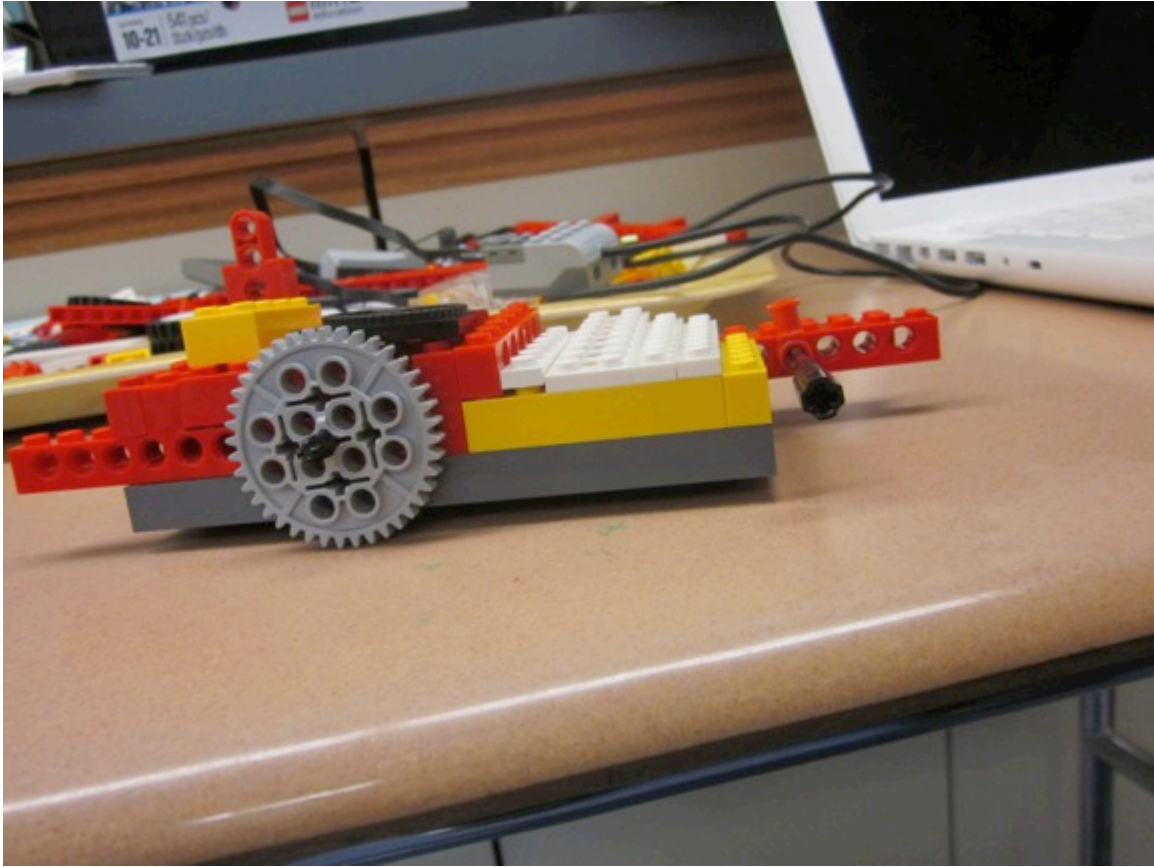


Figure 6 - Boy 4 - Shooting Ride with Snack Bar

This ride does not seem to be modeled on real ride but shoots people out of a tube and they land on a gear. His design was much more sophisticated this year and he took much more time building it. He was not concerned about loose parts and had some trouble clicking in parts that were being interfered with.

Boy 5



Figure 7 - Boy 5 - K - Amusement Park With Multiple Attractions

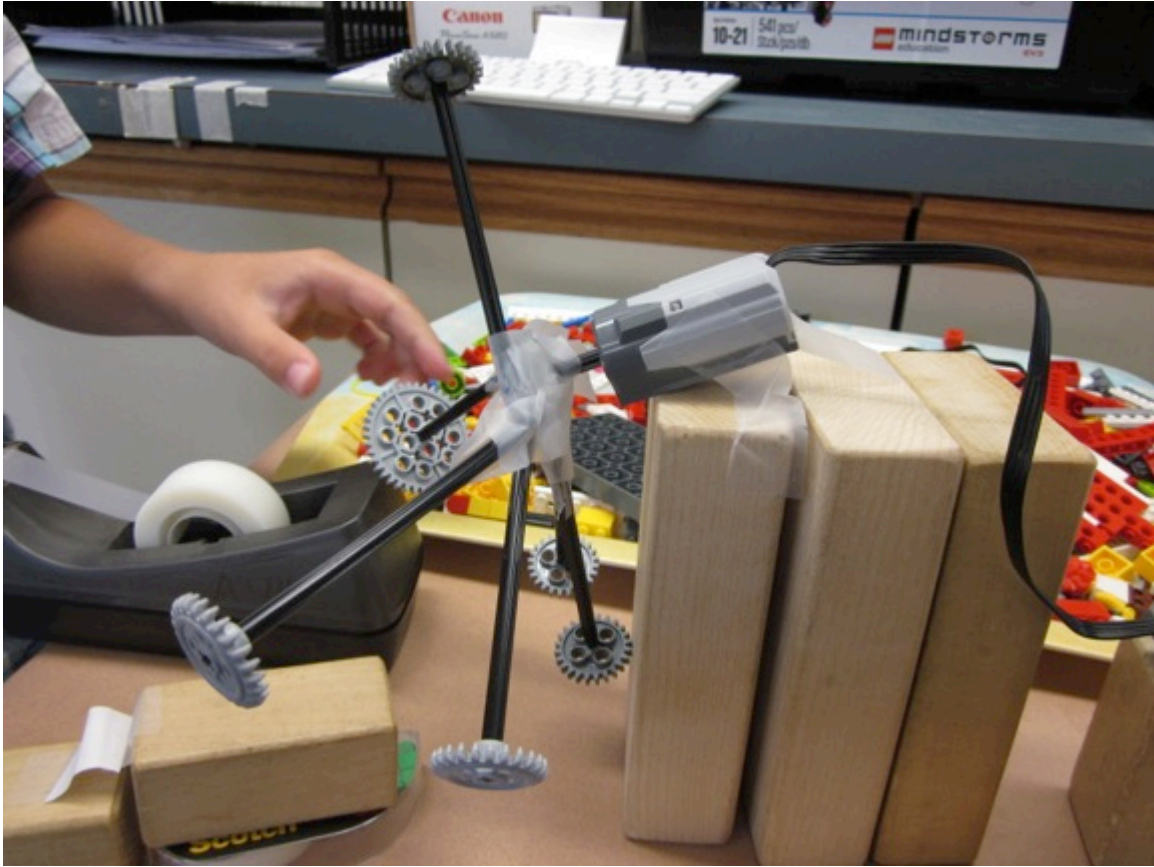


Figure 8 - Boy 5 - Grade 1 - Ferris Wheel

Boy 5, who is very advanced in math and science but perhaps not LEGOs per se, went immediately to a Ferris wheel idea and stayed with it the whole project. It was also clear that he intended to use the motor and computer to animate the ride from early on. I was surprised he used lots of tape to hold different pieces together.

When discussing the use of tape, he said, "It kind of looks simpler than it is. When you get into the details, it's a lot more than it looks like."

Boy 5 was very creative again this year and found the process quite enjoyable.

Boy 6

Boy 6 is new this year and will replace boy 1 in the study. Boy 6 is thought to be creative, bright, and independent.



Figure 9 - Boy 6 - Grade 1 - Car Ride

Boy 6 built an interesting brake system where disks (pulleys) pivoted on an axle. He was reticent about discussing what he was doing. He appeared to bring in a lot of LEGO knowledge from home. He detached the wheels when it came to a point where he really had to build a good chassis. Unlike Girl 3 and others, he did have knowledge of chassis and common LEGO construction techniques.

Girl 1



Figure 10 - Girl 1 - K - Horse and Coral

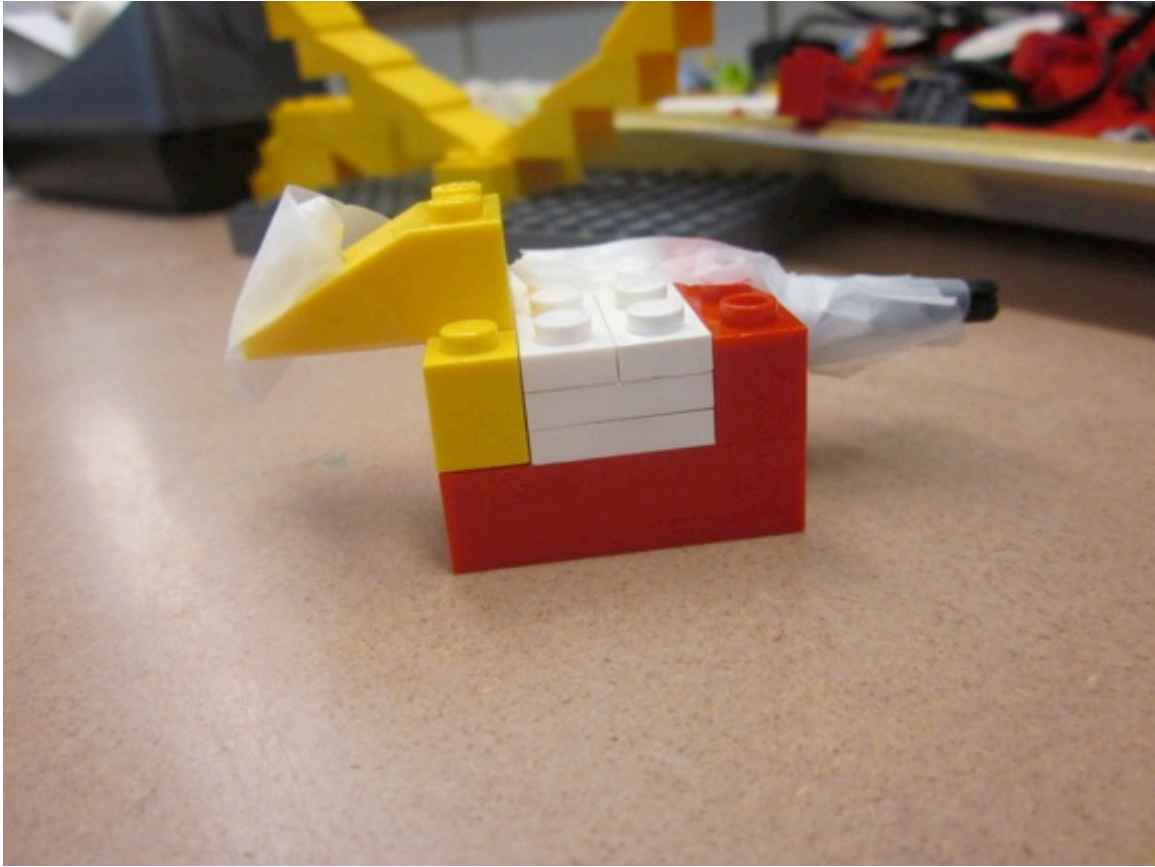


Figure 11 - Girl 1 - Grade 1 - Horse

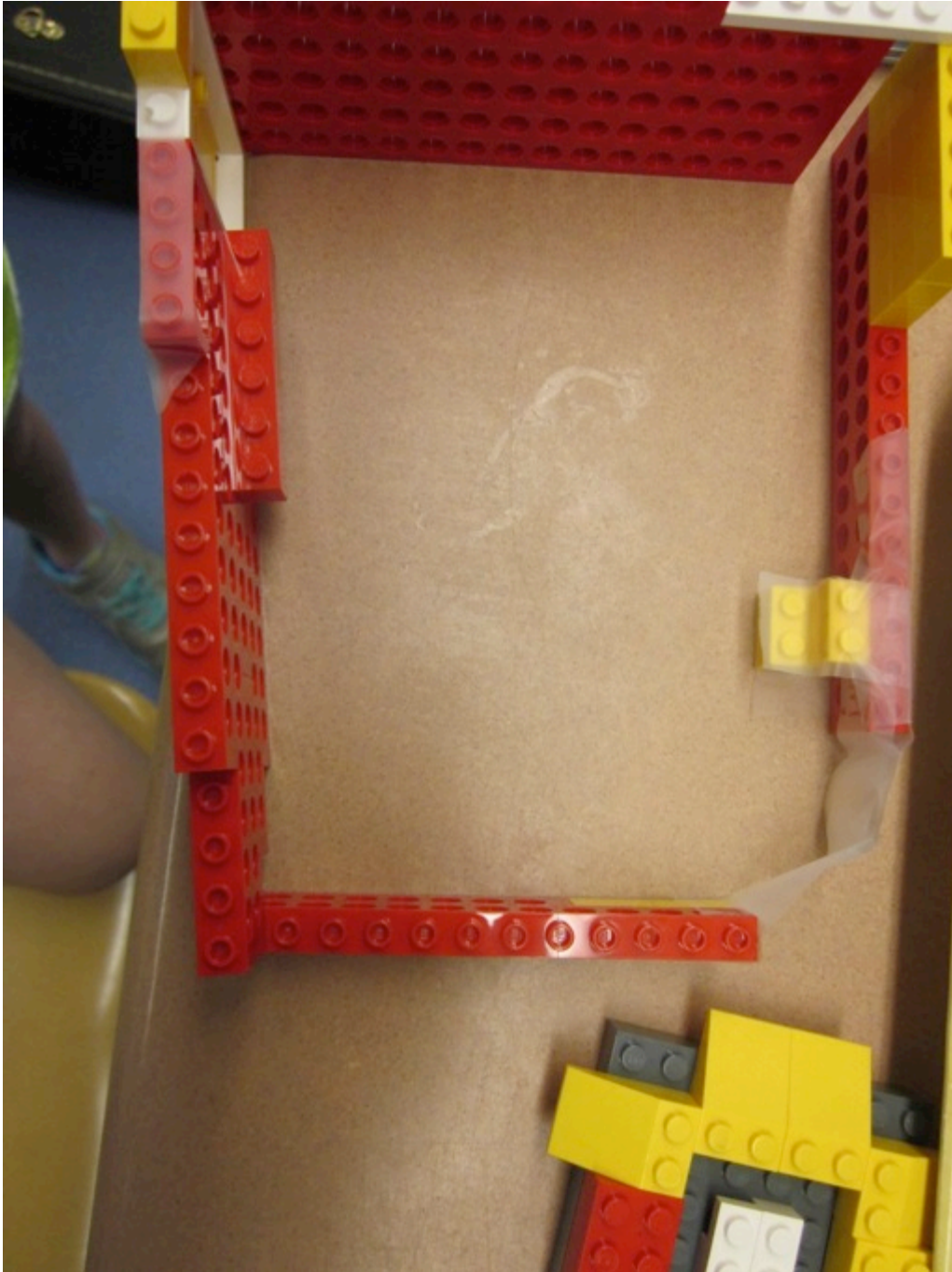


Figure 12 - Girl 1 - Grade 1 - Horse Coral

She started to build a Ferris wheel but it was not going to be stable. Again, we are seeing that first graders are not constrained by adult's notions of what is stable or by conventional designs. For example, this design has no support for the upper levels. When I asked, she planned to make it go "all the way around." Again, first graders do have the ability to project out what will be stable or unstable.

She started to use tape and LEGOs to fasten a star axle to a round beam opening. This reminds me of the importance of teaching stars and rounds, which I have also been noticing as a key concept for older students. She ended up using tape to make a horse and corral. Tape was used extensively to fix construction issues.

Girl 2

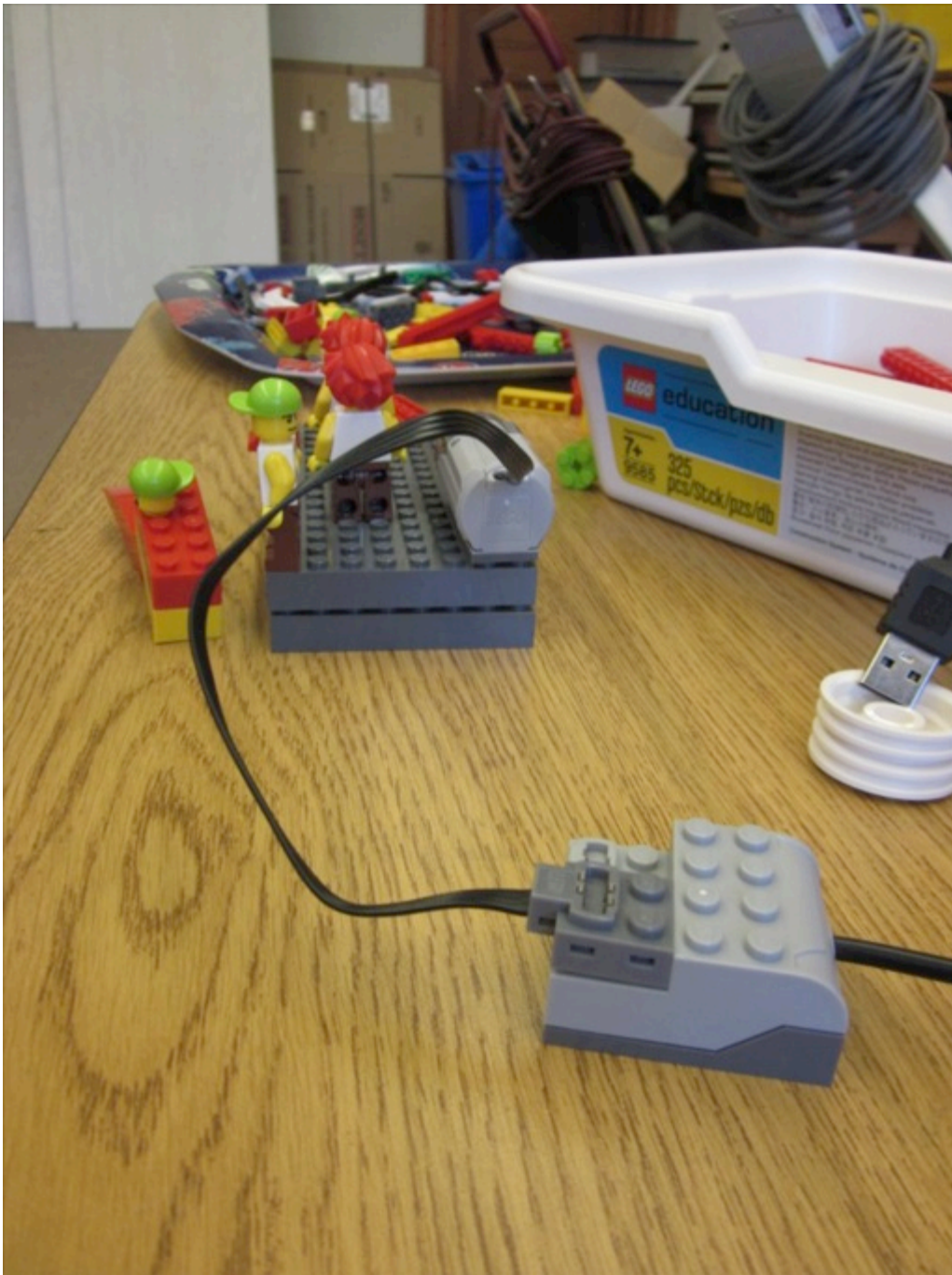


Figure 13 - Girl 1 - K - Fun House



Figure 14 -Girl 2 - Grade 1 - Bridge/Tightrope Ride

We see that designs are really “free form” in first grade and not limited by practical ways of building. For example, she put a gear on the base and initially did not attach it. It was very clear from my questions and her answers that she very much made this up as she went along. This ride was interesting in that it was not modeled after a single real ride but was an amalgamation of different ideas.

Girl 3



Figure 15- Girl 3 - K - Merry Go Round

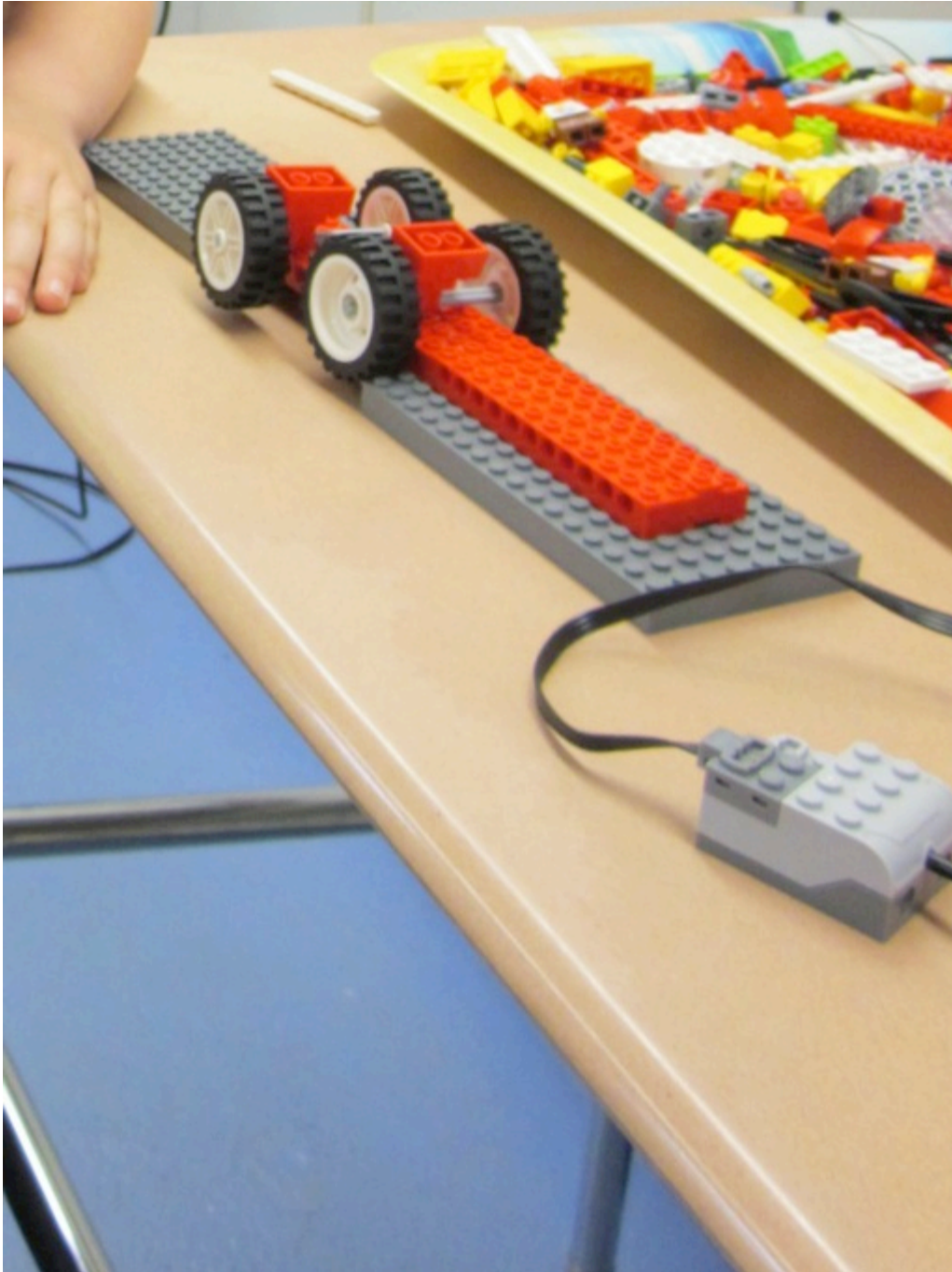


Figure 16 -Girl 3 - Grade 1 - Car Ride

Girl 3 made a LEGO creation this year as opposed to last year's craft creation. She was much quieter this year. She did use symmetry to make her car. She had trouble making a chassis for the car. In fact, the idea of a chassis did not occur to her. She talked about "attaching seats." Here we see that first graders do not generally have the knowledge of common construction techniques that they can draw upon.

Girl 4

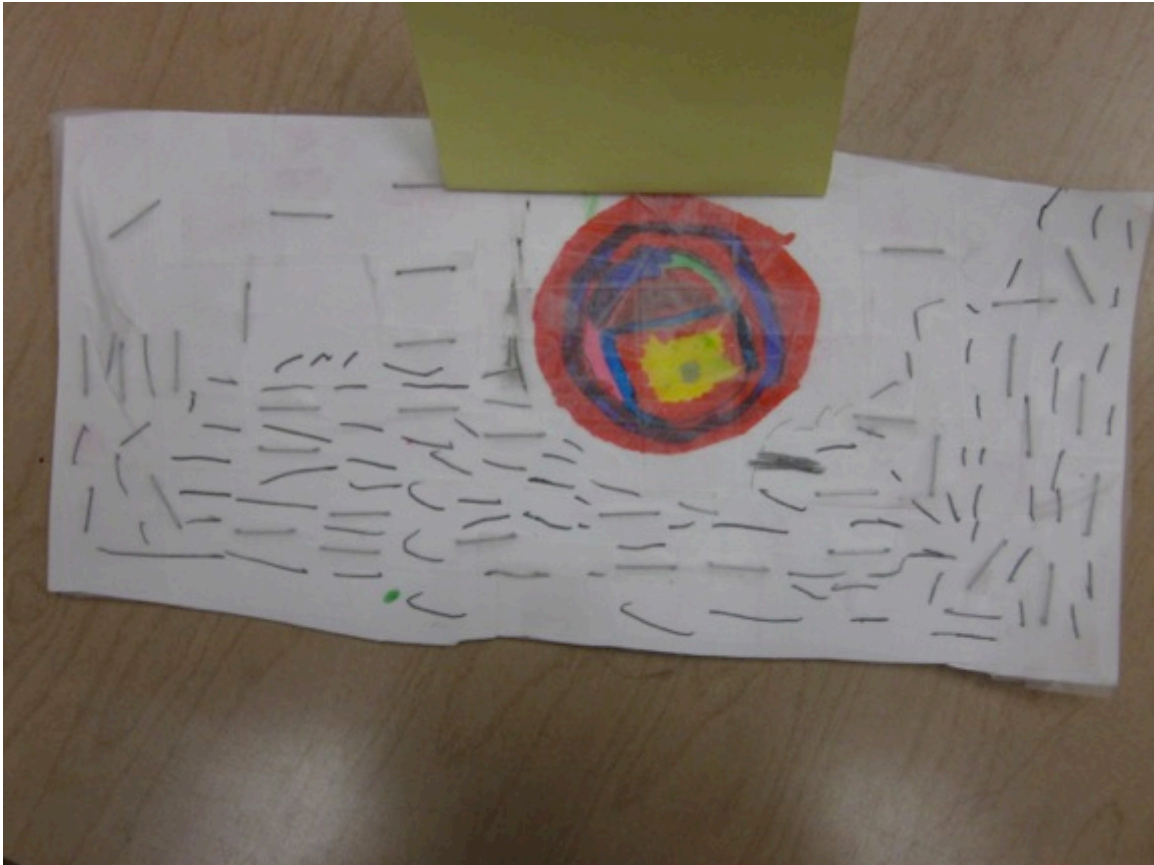


Figure 17 - Girl 4 - K - Ferris Wheel

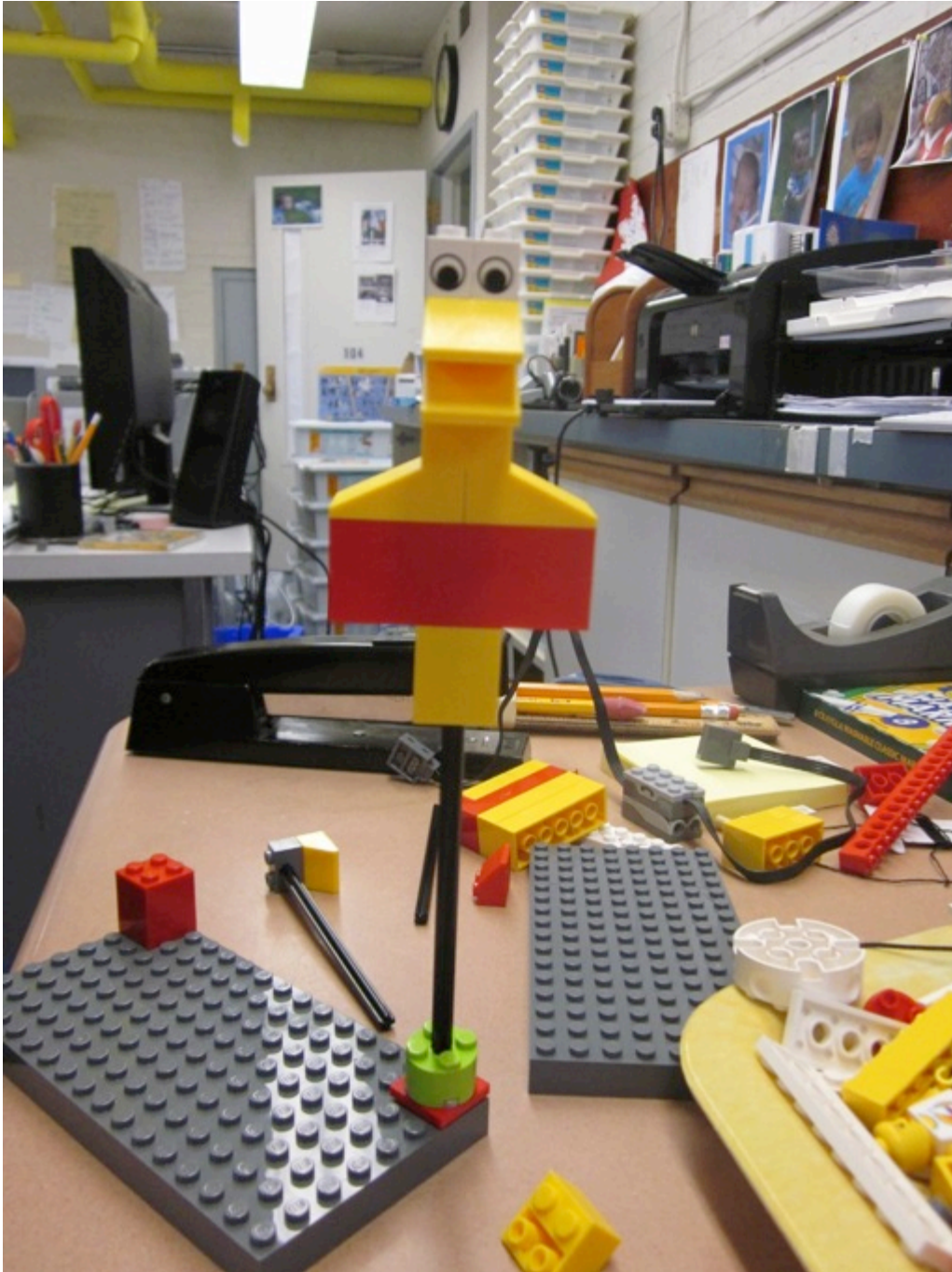


Figure 18 - Girl 4 - Grade 1 - Duck Ride

Girl 4 had some trouble again this year getting started and appears to lack confidence and has difficulty making decisions on what to build. This was the same pattern as last year. She has a very social, interactive style, and is very concerned with social relationships and what other made. She made a LEGO creation this year as opposed to last year's craft creation. It appeared to be modeled on the LEGO Dancing Birds robot we made in class.

Year 1 Summary

Here is my summary of the kindergarten case study last year.

The first thing to note was that seven of eight children choose to use LEGO blocks to construct their rides. A few children were very interested in using the motors and sensors. However, I decided not to bring laptops, which would be needed to do so, because they have not used LEGO WeDo materials in school yet. One very creative student used mixed materials, combining craft materials with LEGO materials. I had a difficult time getting this student to leave. He said that he could have stayed all day. I have noticed this student previously during indoor recess very engaged in similar project using craft materials.

I noticed that many of the children engaged in self-talk as they built. Most were quiet initially but started talking as I gently asked questions about what they were doing. The self-talk varied from pragmatic (centered around their building) to fantasy talk (centered around a drama that the building supported). This made me wonder about the importance of self-talk during building and how it changes over time. Does it change from fantasy to pragmatic self-talk over time? Each subject seemed to have a dominant kind of script or self-talk they used when building, some were socially focused, some on the building, some on the fantasy play.