Motion Observations and Learning

Observations I made about motion are summarized in the class notes. I now write from the perspective of one observing researchers at work. Listening to the recordings of conversations, reviewing notes taken, and examining pictures piqued my curiosity - Each of us received the same directions, and yet our approach to finding the answers were so diverse and at the same time very similar. Out of this observation experience, I gained new insight into how my colleagues approached a task and made sense of a particular question. As a teacher, I recognized the value and richness of creating experiences that allow for individual differences.

JF appeared to be interested in recreating one of Galileo's experiments with inclined planes. She read the experiment – extricating key ideas. She methodically approached the task, changed only one variable at a time (height as measured by books), and recorded her findings in a table format. When done, she walked around the room and observed what others were doing. At various times, she offered suggestions to others on ways to improve a design – "Try this board. It is flat." Sometimes she raised questions – "Shouldn't they all move at the same time? Wouldn't have more to do with friction?" Other times, she became part of another investigation, describing what she saw and suggesting new ideas. When done roaming, JF returned to reading. "I am reading to see which idea to try next."

MC took a very different approach. She seemed to be interested in examining the relationship between lightness and heaviness and its effect on moving down a gentle slope. Before she created her experiment, she began with an exploration of the properties of balls. She held the balls in her hands noting shape, size, and feel. She bounced them individually and simultaneously, noting which landed first (about the same time) and how high each bounced. Her next step was to design an apparatus for measuring how long it would take a hollow (shell) sphere and a solid sphere to roll down a gentle slope. She set a flat, rectangular sheet of cardboard on top of the edge of a box. She marked the starting position. Then she rolled various objects of similar size, but different weight down the slope, timing how long each took, and finally recording this reading in a table in her notebook. Upon completion, she looked up "It's true. The solid sphere and cylinder will travel faster than the spherical and cylindrical shell."

YY explored properties of motion. It seems she is exploring what happens when she throws a ball upward. She runs and throws the ball, trying to catch it. She moves to pendulums exploring from different heights – how many swings before the ball stops? She pushes a ball in anround dish -- How long does it take to come to rest? Her questions begin to center around measuring how long an object takes to come to a rest. What intrigues me is the patterns of her thinking. Here is a snippet of her thoughts.

> "Sometimes I can feel the weight. See the same height. If I move this way, I feel my hands can feel the different weight. So if they will put different efforts on them, so I cannot measure. I jump and my hand will move with my body, then stretch out. I don't put any effort on my hands. Yeah..maybe I can use a board. [She puts two balls on a plastic cover, flips the balls upward.] This is better. Yeah, this whole board I use, then I don't have to worry about if I … yes, here, the middle of the board. Yes, it is almost the same height. Did you notice? But what

does it mean? I am looking for how high they can travel, but I don't know why? Yes, sometimes I can see them at the same height, sometimes not. You can sense the different heights. Let's see the same height."

She moves to the table, sits, fingers on her chin, brow furrowed. She is pensive. She gets up. Moves to another experiment. Again, she thinks aloud. Tries one thing, then another, and puzzles over what she has seen. I have a sense that she is comparing her observations to those of Galileo's. How does it fit? How did he come to his conclusions?

LJ works on inclined planes. Experiments with pushing balls, rolling balls and changing slopes, one idea builds upon the next.

Everyday Motions

Motion and time – Galileo spent a lifetime observing, examining, and describing how things move. Motion is something that is all around me, yet I don't think I have taken much notice of it. This week I paid particular attention to two kinds of "non-natural" motions – walking across streets and moving cars. Stop, go, stop, go – how do we measure the motion? I realized the significance of timing – how do you measure steps, starts and stops. I know this about the crossing the street – Walking at a comfortable pace, I need 6 seconds to cross most of the intersections. I have used the counting down seconds on the lights to gauge whether to walk, run, or keep still. I know from watching and measuring is that certain lights turn green the minute that second flashes ZERO. I played with water dripping from the kitchen faucet. When the faucet was wide open – a large flow of water with no evidence of droplets, a continuous sound. I close the faucet incrementally. As I do this, the stream of water narrows until finally I see tiny droplets. I wish I had a strobe light or a way to freeze the motion of each drop. The sound changes from one whoosh to isolated taps on the sink basin. They are rhythmical, keeping a beat. I watch cars stopping and going. How could I measure motion? What is there that would give me a clue to the speed or the rhythms? Wheel rims!!! I watch how what I see changes as a car slows and comes to a stop or starts and speeds up. At rest, the spokes and the hub are visible. I can detect the individual pieces. As the car begins to move, the spokes begin to rotate in a regular movement until I see a whir of white. At this point the car is moving (not so fast, but fast enough that the tires are turning at a rate that I can no longer see the details of the hub.) These observations make me think about the difference between motion, acceleration and deceleration. What do these really mean? How do we measure them?

I also think about the motion of the moon. Last semester, we tracked the changes of the moon. Our class spent many an hour trying to discern how the moon moved in the sky. What was its path? Then one day, something strikes us – the moon does have its orbit and does move, but the movement we see during the course of a day is not really the movement of the moon. It is the movement of the earth!!! What a revelation. Held to the surface of the earth by gravity, it seems to us that we control our motion and movements; we do not move as fast as the earth. We are hardly aware that the earth is spinning.

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