WHITEBOARDING IN CONCEPTUAL PHYSICS

EVIDENCE FROM A FIRST YEAR EXPERIENCE

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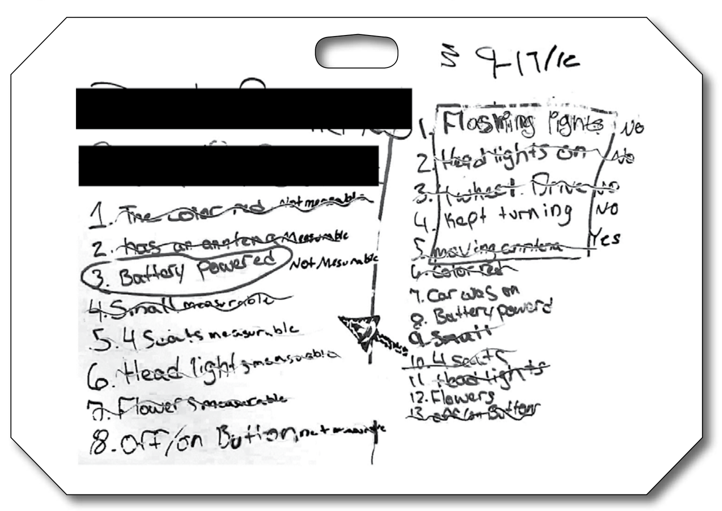
During the 2012-2013 school year, Riverside High School, a persistently low achieving school in the Buffalo Public School District (Buffalo, NY), launched their first offering of Conceptual Physics to support the a new Health Science Academy within the school. Two teachers integrated whiteboarding into three sections of Conceptual Physics. Despite chronic absenteeism, high levels of initial student apathy, a preponderance of ESL students, and extraordinarily diverse student demographics, whiteboards demonstrated profound levels of student thinking and highly varied interpretations of shared evidence not typically associated with students in low performing urban schools. Evidence gathered from student whiteboards demonstrated cognitive interaction beyond that typically reflected on high stakes standardized testing for this student population.

This project was supported by Buffalo State College, and the National Science Foundation (NSF) funded Interdisciplinary Science and Engineering Partnership (ISEP) MSP project.

WHAT WE WHITEBOARD

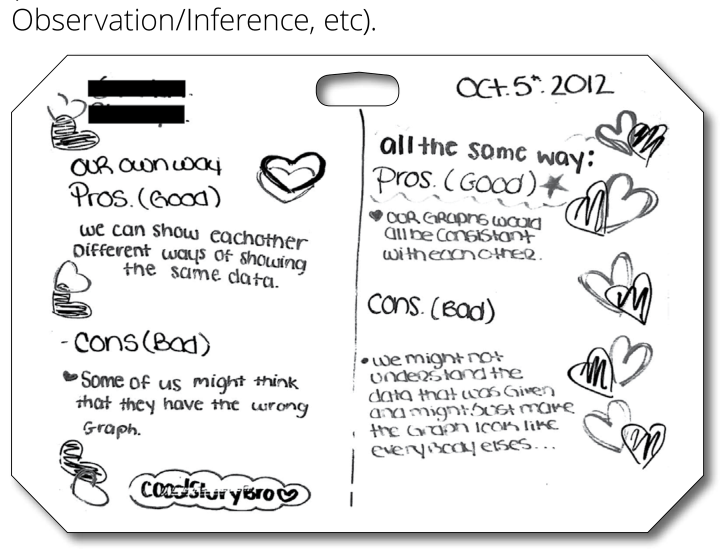
Brainstorming

Creates a profoundly diverse pool of student thinking that is then accessible to everyone in the class.



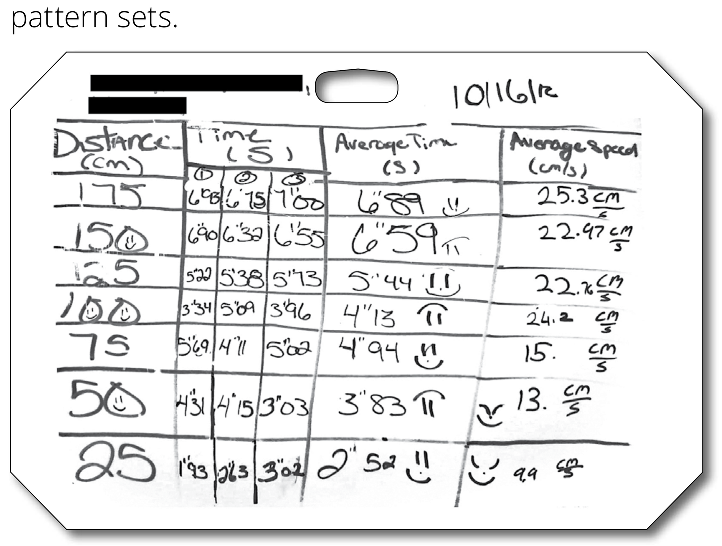
Evaluations

Investigate various aspects of a given idea or topic (Pros/Cons, Cost/Benefit, Similarities/Differences, Observation/Inference, etc).



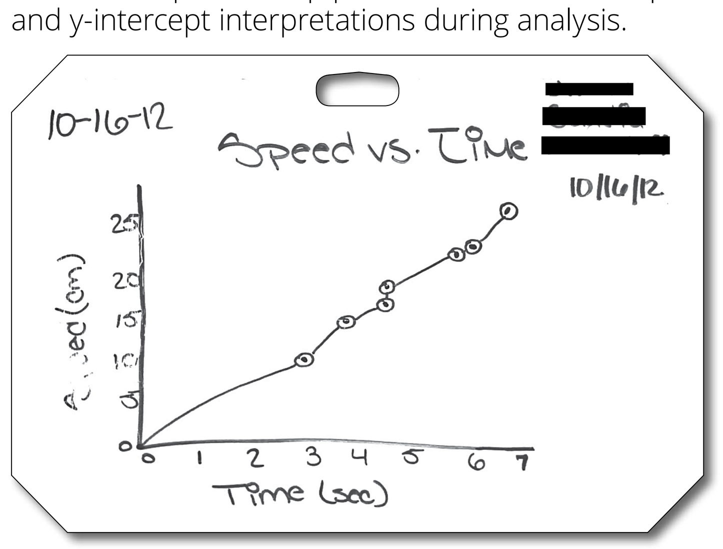
Data

Present data for discussion and allows the entire class to analyze and interpret the results. This enables students to see consistent, or universal, pattern sets.



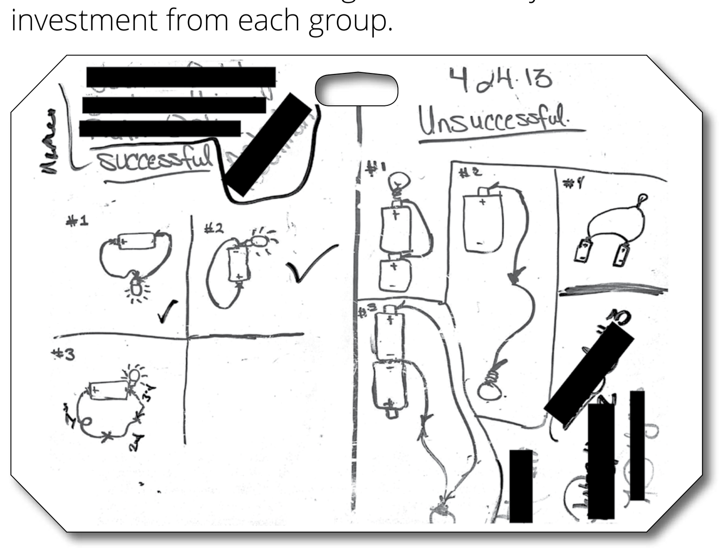
Graphs

Visually represent data collected and the associated best-fit line used in the group's analysis. Carefully chosen setups can help provide evidence for slope and y-intercept interpretations during analysis.



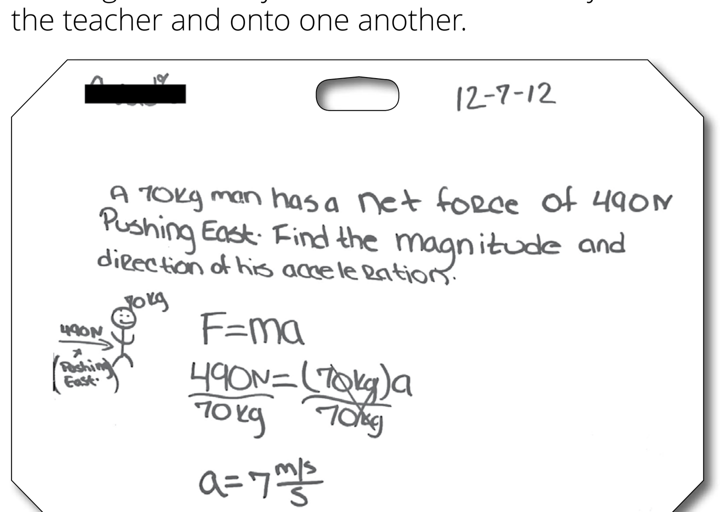
Diagrams

Visualize each group's unique setups, attempts, and their observed outcome. This allows a large number of situations to be investigated with only a minimal investment from each group.



Homework Problems

Students learn from one another and create a learning community that shifts reliance away from the teacher and onto one another.



SAME EXPERIENCE DIFFERENT THINKING

Shared experience, often times, is not sufficient to build a cohesive conceptual framework in the minds of our students. Despite students working through the same activities, with the same materials, and obtaining the same results, the scientific models our students construct based on these results can vary dramatically.

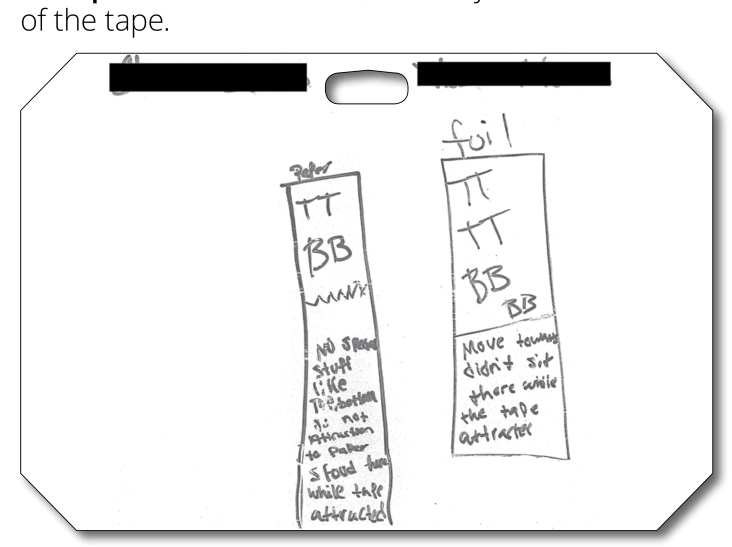
The following whiteboards provide examples of models created by students regarding "action at a distance" using sticky tape, paper and aluminum foil[1]. Each group obtained the same data based on the activity:

	Top	Bottom	Paper	Foil
Top	Repel	Attract	Attract	Attract
Bottom	Attract	Repel	Attract	Attract
Paper	Attract	Attract	None	None
Foil	Attract	Attract	None	None

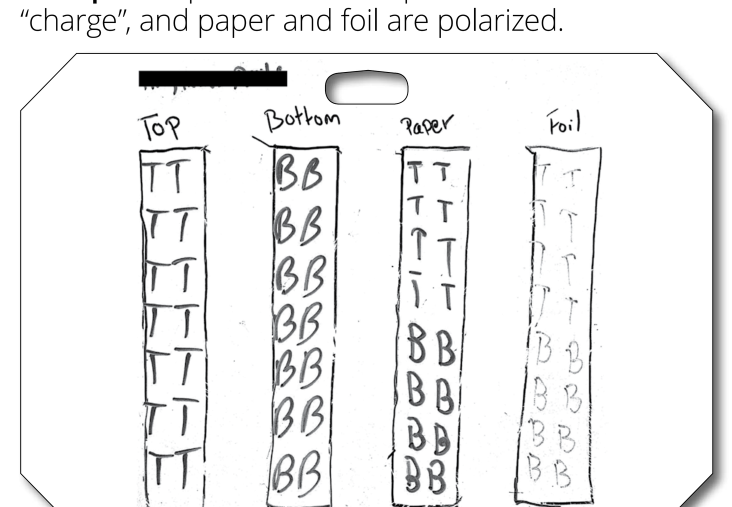
Typically, this provides sufficient evidence for a teacher to assume students are on the right track and have a good understanding of the concepts represented. However, when students are asked to draw, and more importantly, discuss, a model to explain their results, the way in which each group internalizes the results shows diverse variations in their understanding. Through whiteboarding, and classroom discourse based on those whiteboards, students can work together in a scientific community coming to a standardized. In doing this, our students are able to develop a consistent model and we, as the teacher, have a clearer picture of our students conceptual framework.

It was provided to students that both top tape and bottom tape contained "something unique" that made them behave like a top tape or bottom tape. This "stuff" was appropriately designated T-stuff and B-stuff. The class participated in a class whiteboard session that dispelled the possibility of paper and foil each having their own set of "stuff" that makes them interact as observed (no P-stuff or F-stuff). Students were asked to draw appropriate models for all four strips that could explain the 16 interactions observed.

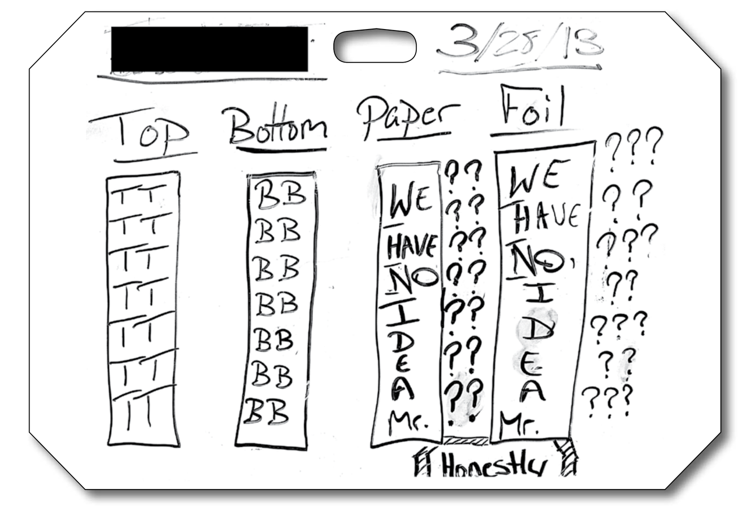
Group 1: Polarized model, but only for one section of the tape.



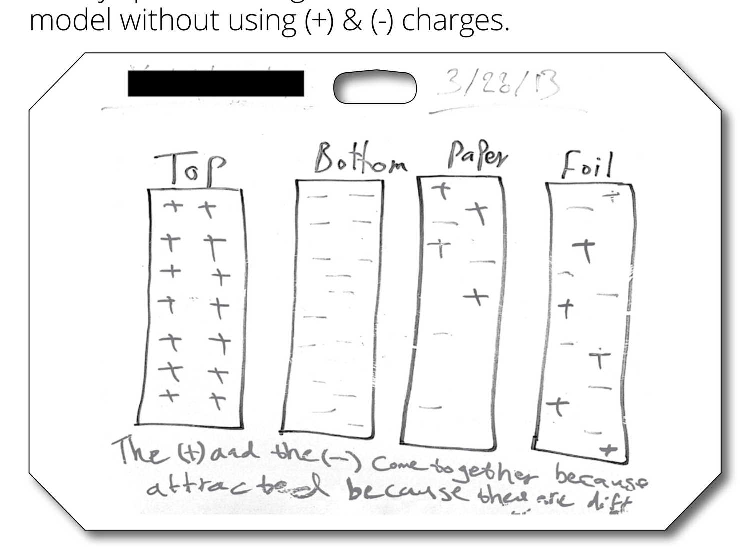
Group 2: Top and Bottom tapes have their own "charge", and paper and foil are polarized.



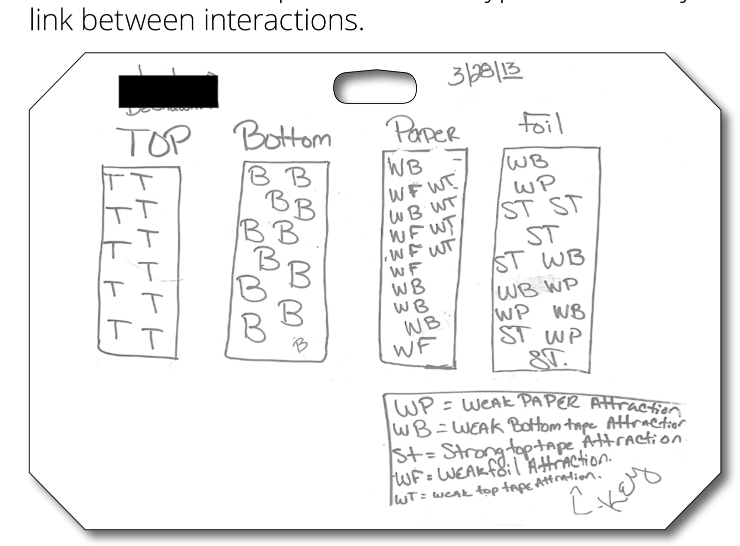
Group 3: Top and Bottom tapes have their own "charge", but cannot model the interactions of paper and foil.



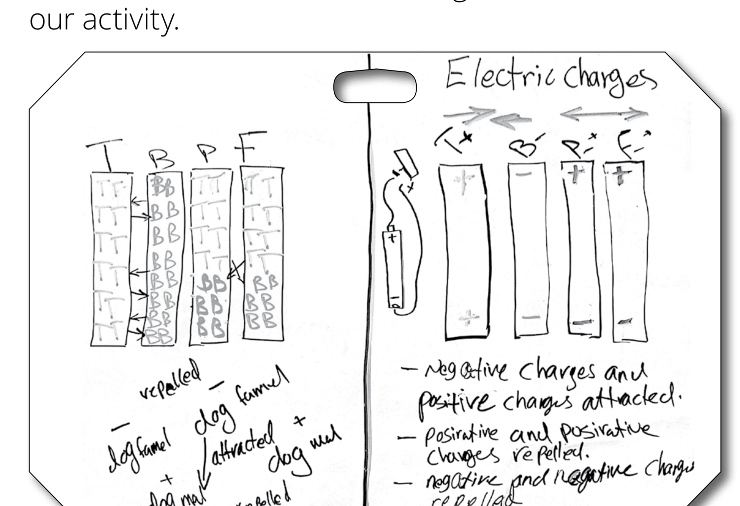
Group 4: Related the behavior to previously learned material (+ & - charges). Paper and foil have these evenly spread throughout. Unable to create their model without using (+) & (-) charges.



Group 5: Top and Bottom tapes have their own "charge", but assign individual characteristics to each interaction observed. Each observation is attributed to a unique interaction type without any link between interactions.



Group 6: Top and Bottom tapes have their own "charge", but paper and foil are polarized without charges between. Required a charge model be drawn first, and then reverse-engineered it to fit our activity.

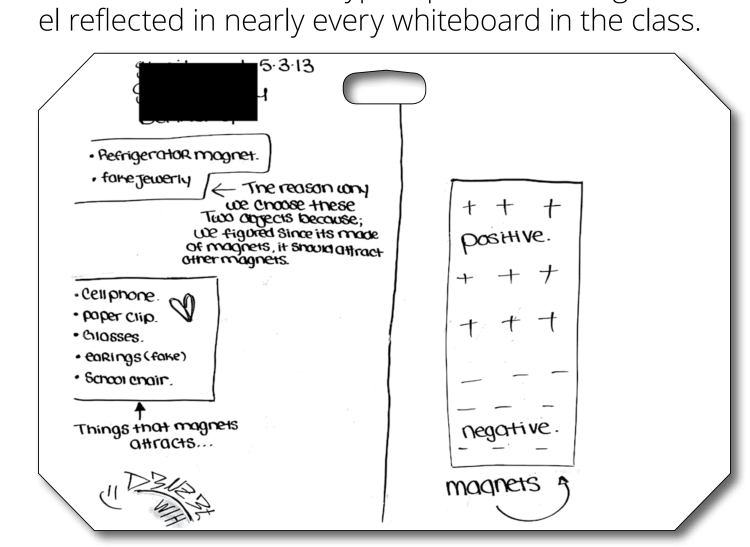


EVOLUTION OF A MODEL

Over the course of a month, students were asked to develop, and revise, a model to explain magnetic interactions based on a series of activities from the Physics and Everyday Thinking (PET) curriculum. The whiteboards presented follow the evolution of one group of students as they worked through the activities. Due to profound levels of absenteeism, the exact group members changed with the exception of two key students who were present for each step.

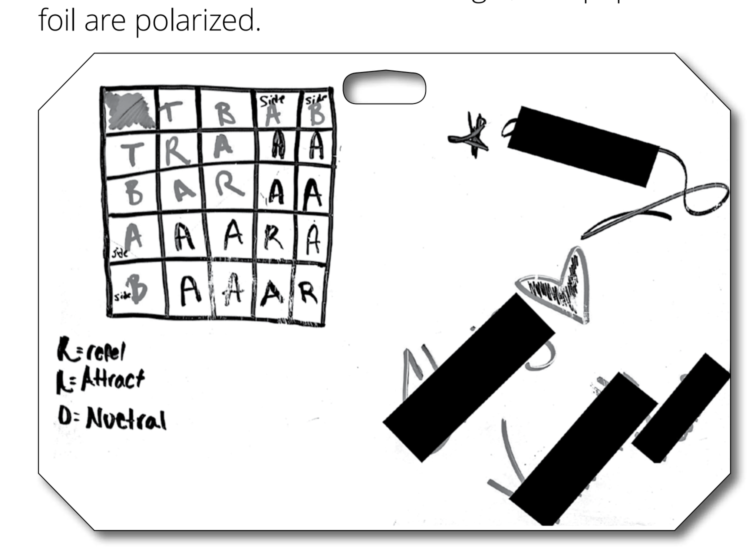
Board 1: Student created a list of objects that would interact with a magnet on the left hand side. Group member indicated that these objects were specifically chosen because they have seen a magnet interact with them.

Students were asked to draw a model of what is taking place inside the magnet, similar to our sticky tape activity above (performed before this activity), that makes a magnet behave like a magnet. The model drawn shows a typical polarized charge model reflected in nearly every whiteboard in the class.



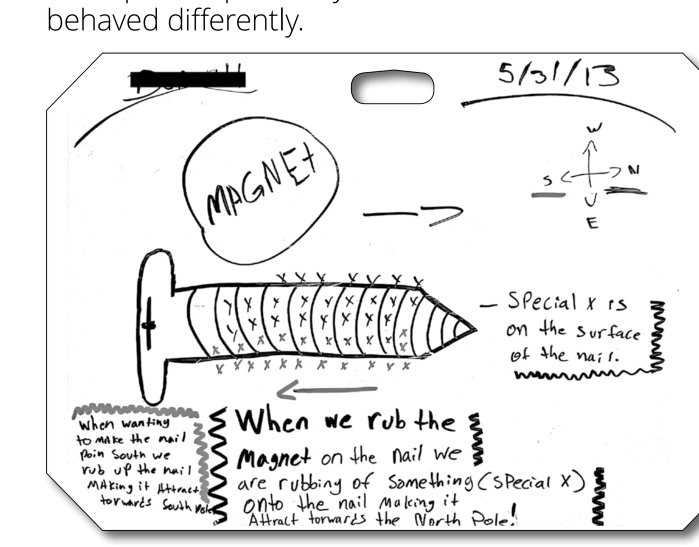
Board 2: Based on the charge model, students were asked to observe the interaction of Top & Bottom tapes with each side of a magnet (replacing the paper and foil with side A and side B of the magnet).

The group discussion indicated that the magnets behaved similar to the top tape and bottom tape, but magnets must be different since the magnets did not show any repulsion with either tape. Therefore, the polarized charge model could not be accurate and failed to explain the observations. A new model was needed.have their own "charge", and paper and foil are polarized.

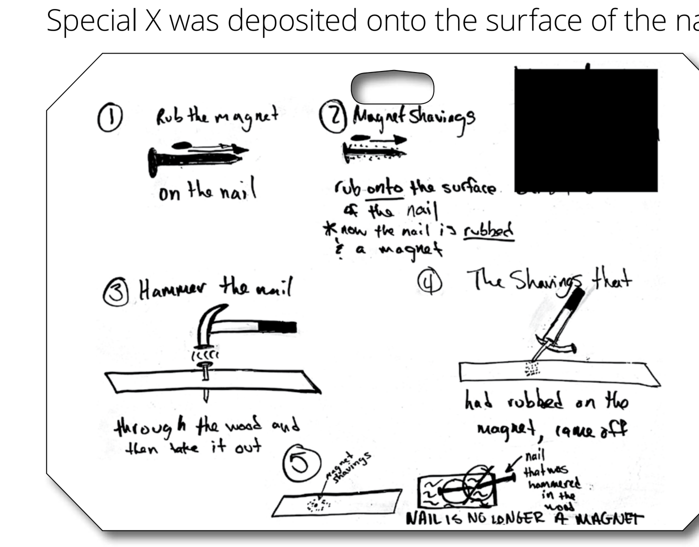


Board 3: After disproving the polarized charge model, the class was unable to develop a new model of magnetism. Based on this, it was clear the students needed additional information before attempting a new model of magnetism. The class performed an activity where they rubbed iron nails with magnets and discovered that the rubbed nails then behaved like magnets.

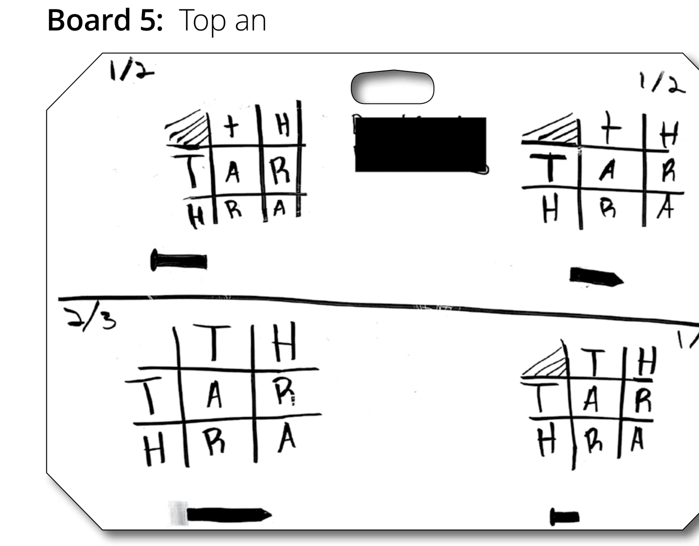
After rubbing iron nails with magnets, the class decided to attempt a second model of magnetism. The result took into account that rubbing a nail with a magnet changed how that nail behaved. The new model takes into account that rubbing a nail with a magnet will change its behavior, but failed to attempt to explain why each end of the nail behaved differently.



Board 4: Having never seen a "powdered donut" version of magnetism, as the group named it, the group was asked to come up with their own test for their model that could determine whether or not Special X was deposited onto the surface of the nail.



Board 5: Top an



Conclusion...