ENGINEERING EDUCATION RESEARCH WITH A FOCUS ON ROBOTICS

JOHN HEFFERNAN

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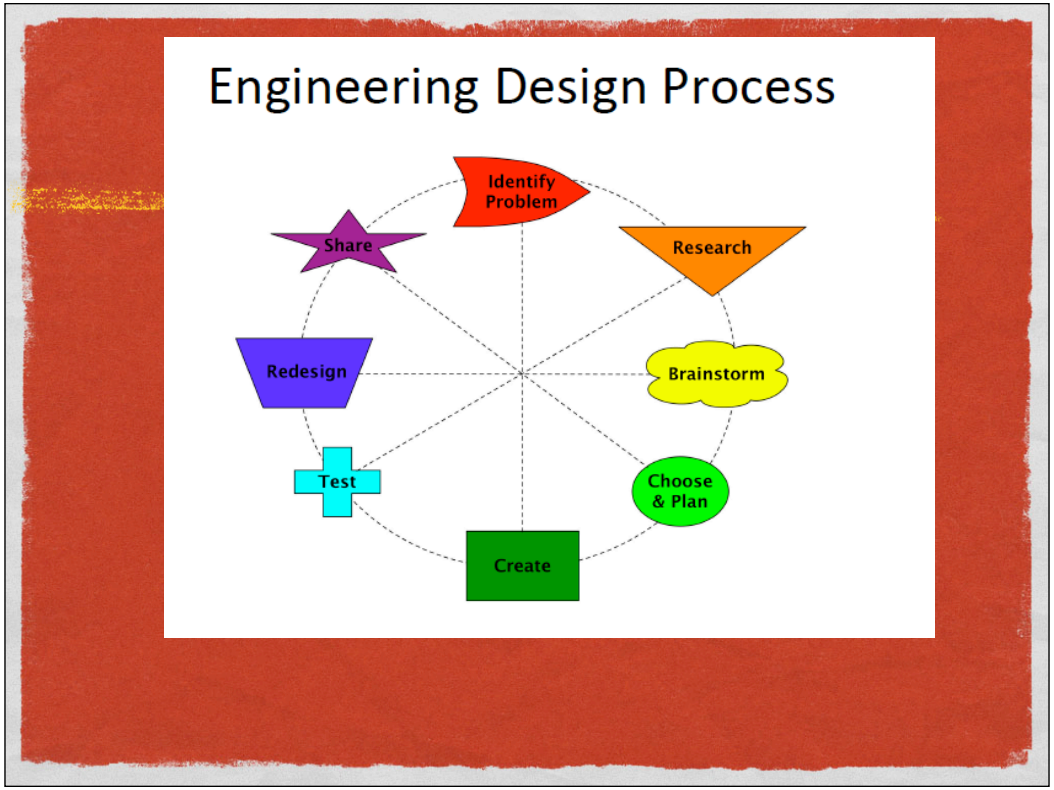
INTRODUCTION

- Focus is engineering education with a focus on robotics
- Context is learning transfer
- Hands on activities will connect experience to research papers read
- Think about methods used in this class as it relates to the research
- Teacher action research will also be presented



Go over and explain: step 1 sometimes overlooked but critical. The same, in essence as other processes.

SETUP QUESTIONS

- As you experience the LEGO WeDo Dancing Birds activity, use the handout make connections to the papers read
- Use your own method/notes if desired
- Reflect on the methods used by presenter as well

DANCING BIRD ACTIVITY

- Build Dancing Bird with partner according to the directions
- Create a simple program to make the birds move for 10 seconds
- Do the LEGO created experiment with the pulleys and belts
- Embellish your program if time permits

REFLECTION

- Discuss experience of Dancing Birds activity with a focus on how it relates to readings
- What STEM learning did you experience? 21st Century Skills?

OPEN ENDED CHALLENGE
OPEN ENDED ACTIVITY

- Build an amusement park ride that is fun and safe
- Only use parts in your kit
- 30-40 minutes
- Use words and/or pictures to plan a ride
- “Mistakes” are progress

REFLECTION AND CONECTIONS TO READINGS

- Discuss your experience and any connections you noted to the readings
- What STEM learning did you exerience? 21st Century learning?
- How did this differ from the more structured activity?
- How did you experience the engineering design process?

Sage on stage versus coach
Build on prior experience

CONSTRAINTS (TIME)

- Free explore
- Science concept sequence

Lego Robots directly tap into the creative play urge of children in a healthy and educational way. A PK-6 robotics curriculum (such as Elementary Engineering Curriculum) is needed to support and sustain the natural engineering instincts of young children until formal engineering education starts.

What’s going on here? Have you seen your kids doing something like this? What does this have to do with learning?

Isn’t that where the urge to engineer comes from?

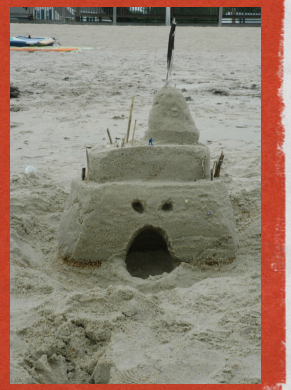
TAP CREATIVE PLAY

It's more fun to actually be building something. If you took a class in robots and just learned about things, if the teacher just drilled information into your head, it would not be as fun as building and experiencing it to learn.

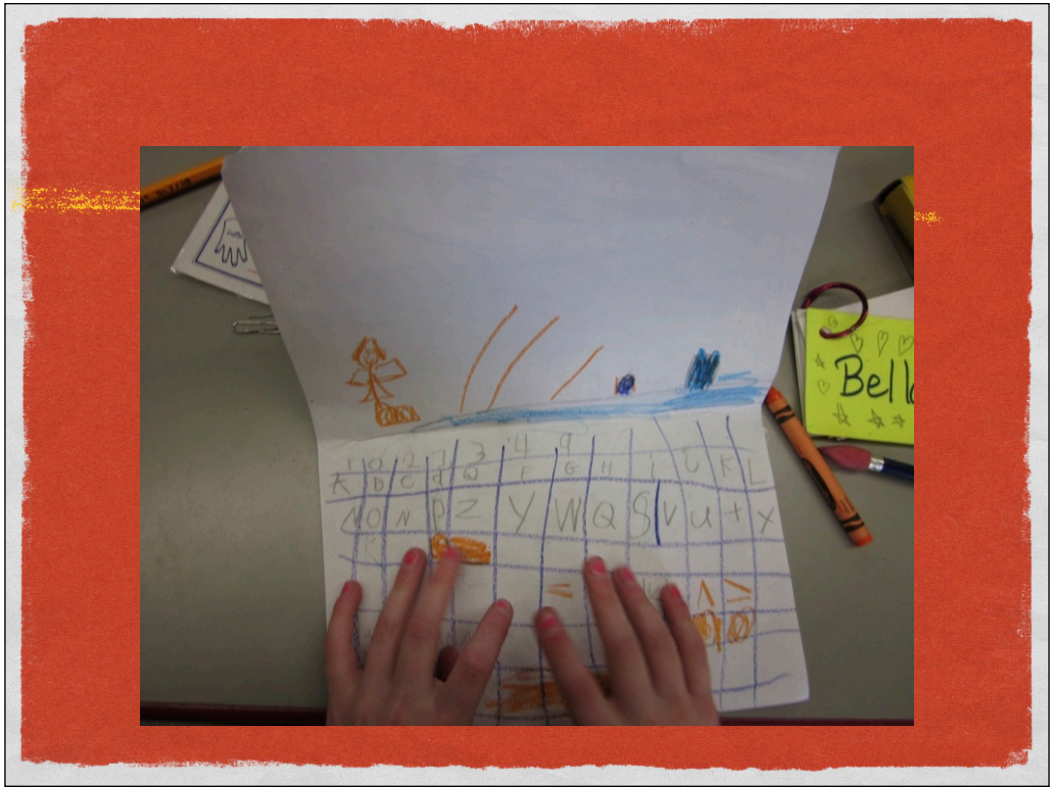
Grade 6 Girl 2

TAP CREATIVE PLAY

- Who is tapping into creative play? Are we?



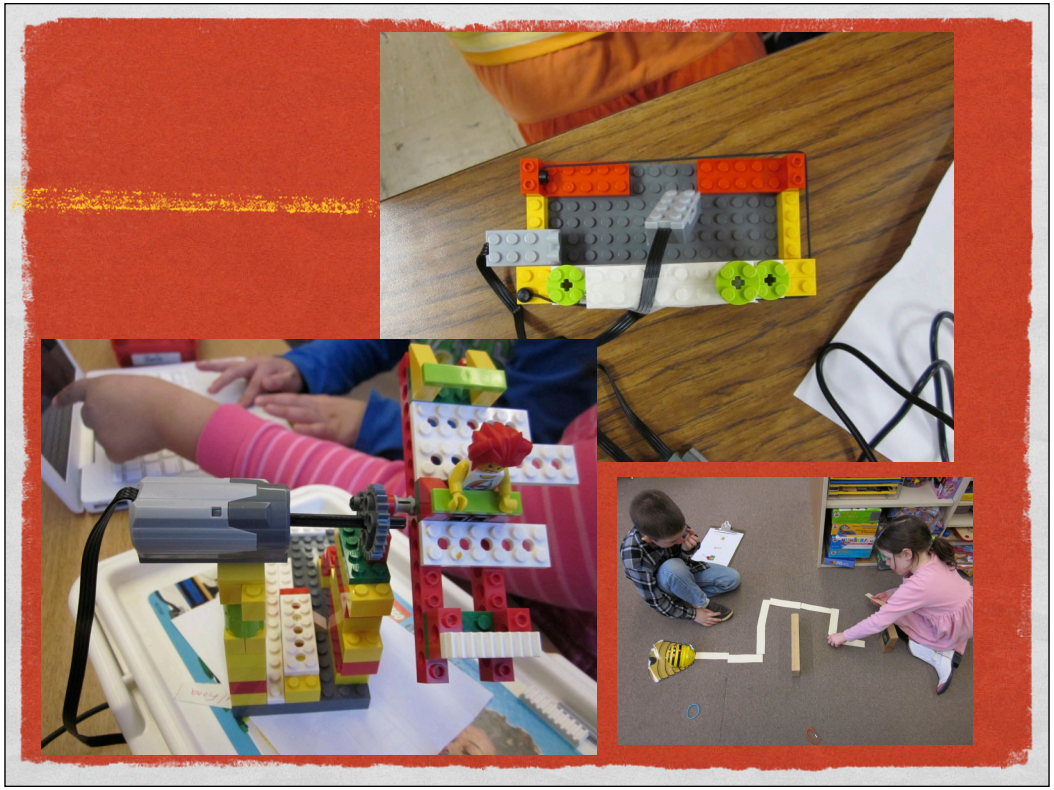
What we see at recess? Are they not getting it at school?



Lego Robots directly tap into the creative play urge of children in a healthy and educational way

WHY ROBOTS?

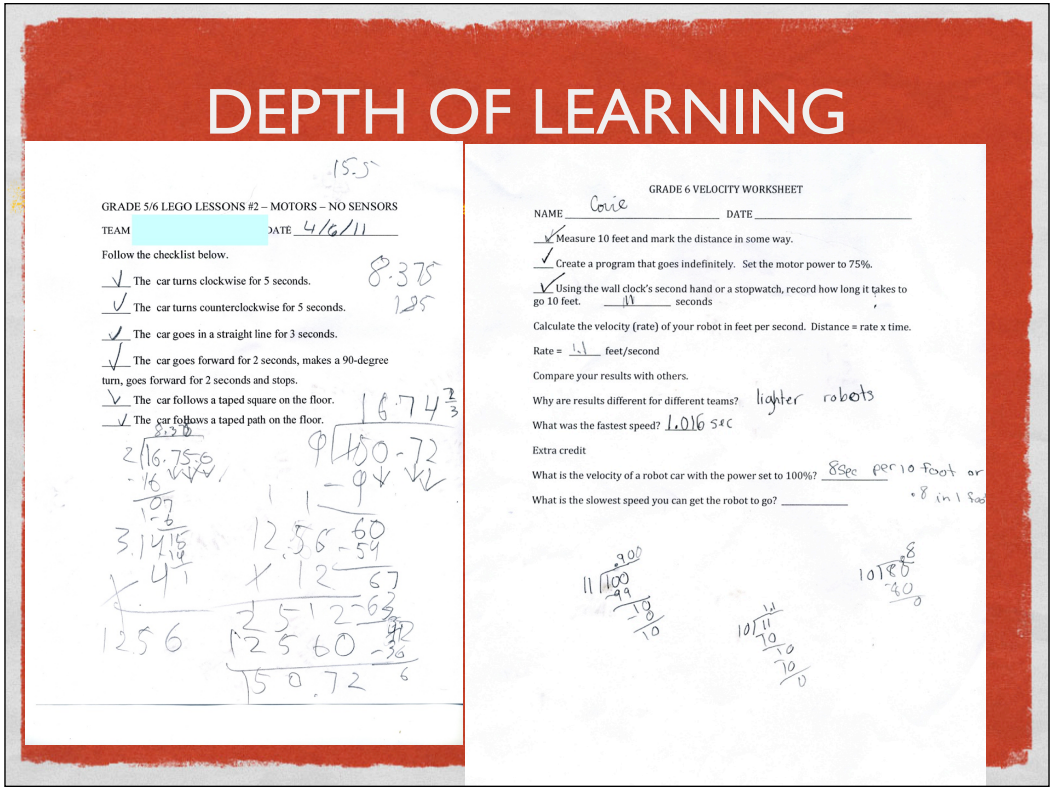
- Engineering can be taught in many ways, why Lego Robots?
- Familiar, fun, fantasy
- They can be programmed, adds “life”
- Tech component built in
- Math, science, ELA as well



Some open ended challenge design from grades K, 2, and 4. Name challenges. Challenges are important to really experience engineering and also to see where the students can take things. Critical for (underserved) students who need more challenges.

YEAR 1 CLEVER SOLUTION

DEPTH OF LEARNING



GRADE 5/6 LEGO LESSONS #2 – MOTORS – NO SENSORS

TEAM [redacted] DATE 4/6/11

Follow the checklist below.

- √ The car turns clockwise for 5 seconds.
- √ The car turns counterclockwise for 5 seconds.
- √ The car goes in a straight line for 3 seconds.
- √ The car goes forward for 2 seconds, makes a 90-degree turn, goes forward for 2 seconds and stops.
- √ The car follows a taped square on the floor.
- √ The car follows a taped path on the floor.

GRADE 6 VELOCITY WORKSHEET

NAME Corie DATE

- √ Measure 10 feet and mark the distance in some way.
- √ Create a program that goes indefinitely. Set the motor power to 75%.
- √ Using the wall clock's second hand or a stopwatch, record how long it takes to go 10 feet. 11 seconds

Calculate the velocity (rate) of your robot in feet per second. Distance = rate x time.

Rate = 1.1 feet/second

Compare your results with others.

Why are results different for different teams? lighter robots

What was the fastest speed? 1.016 sec

Extra credit

What is the velocity of a robot car with the power set to 100%? 8sec per 10 foot or .8 in 1 sec

What is the slowest speed you can get the robot to go? _____

How much more meaningful is this than a workbook sheet on velocity, long division? Learning is in context of solving of problem. Saw many examples where deeper understanding was missing until they had to actual use their math. Think of one!???

FUN

It was hard so it made us jump up and down when it finally worked. *Grade 5 Girls Team 1*

Example of Scarlet running back and forth from computer to test area

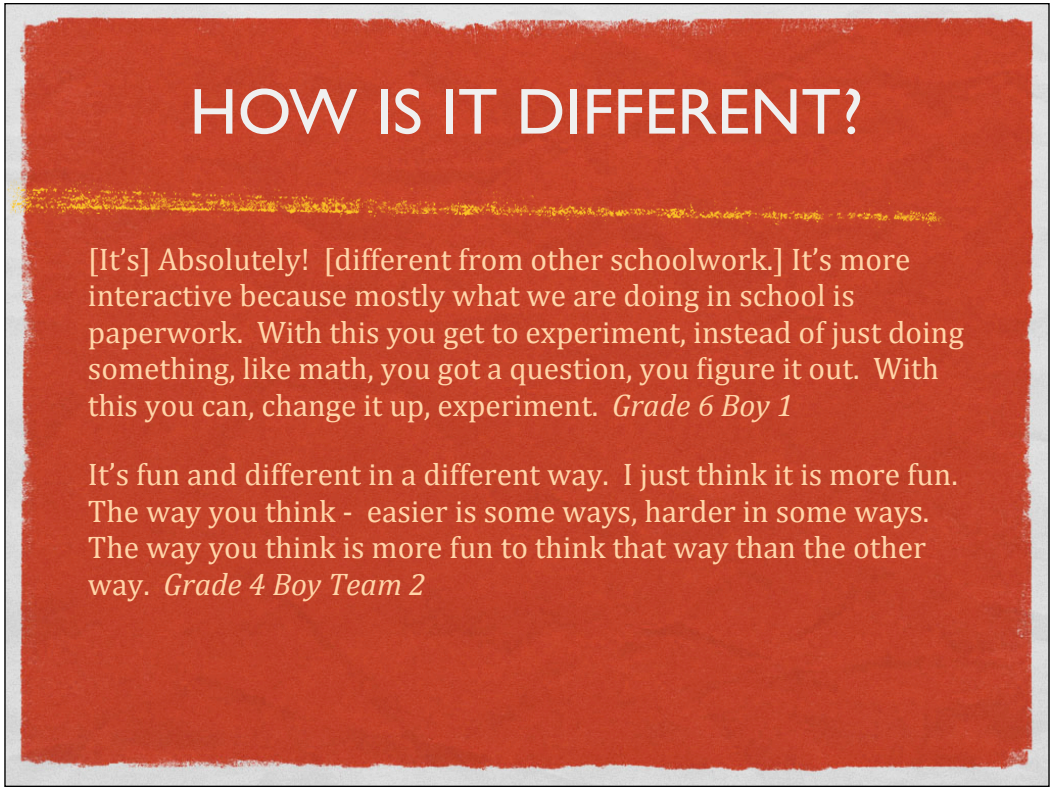
MOTIVATING

RESEARCH QUESTIONS

- Context: PK-6 Elementary Engineering Curriculum with open ended challenges for grades K, 2, 4, and 6. See kidsengineer.com for curriculum.
- What are the phases of engineering development in young students? (Case study)
- How do elementary schools support (or not support) engineering development in students? (Survey)
- Can a PK-6 program affect interest in STEM fields? (Survey, Interviews)

STUDENT VIDEO INTERVIEWS

- Done May/June 2011
- Had a flexible set of questions
- Done after recent robotics units
- Grades 4, 5, and 6
- Coded responses



Do you think this is fun and engaging for kids?

QUOTES

I didn't think you would use all that math and science to build that robot. Grade 6 Girl 2

It's more fun [than usual schoolwork.] It's a lot different – sometimes mathematical. You have to think in a different way. This would make this, would make this, happen. Each step is connected. Grade 4 Boy Team

Integration examples: solve a problem from a story (chair engineering, better mousetrap (Ralph), design an instrument, decorate robots

WHAT DID YOU LIKE ABOUT ROBOTICS?

What did you like about robotics?

24 Mentioned the project as fun
15 Got to build/hands on
8 Different than other school work/special/exciting
7 Liked the programming even though it was hard
5 Cool
4 It was satisfying/exciting getting things to work
2 Liked the trial and error
2 Had to learn to compromise, work together
2 Got to move around, not stay in seat

WHAT WAS HARD?

4 Being patient

2 Parts falling off

2 Programming

2 Programming sensors

WHAT DID YOU LEARN?

7 Programming

4 Math

3 Science/how things work

2 Technology

2 Engineering

2 Building

2 Distance = rate x time

RESEARCH - INTERVIEW RESULTS

- See handout for more student quotes
- Student very aware of how they are being taught
- Prefer hands on activities and believe they learn better that way

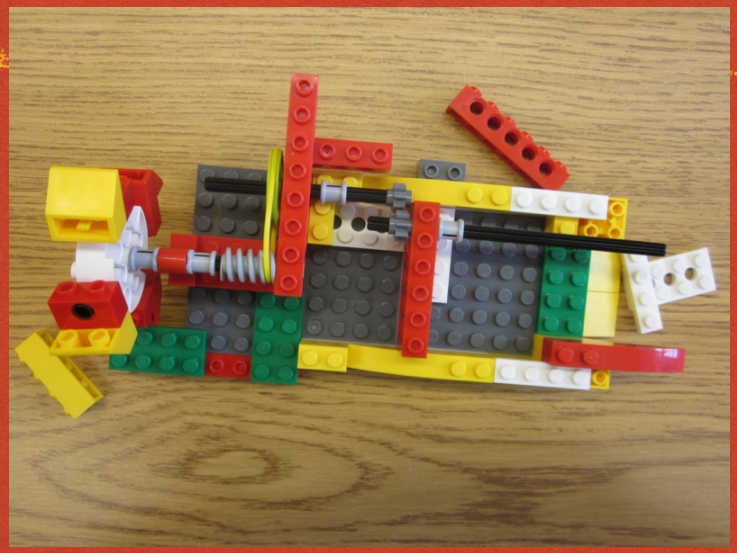
CASE STUDY

- Follow 8 current K kids for 7 years
- Yearly open ended challenge
- Videotape and photograph artifacts
- Learn more about the phases of engineering in young children

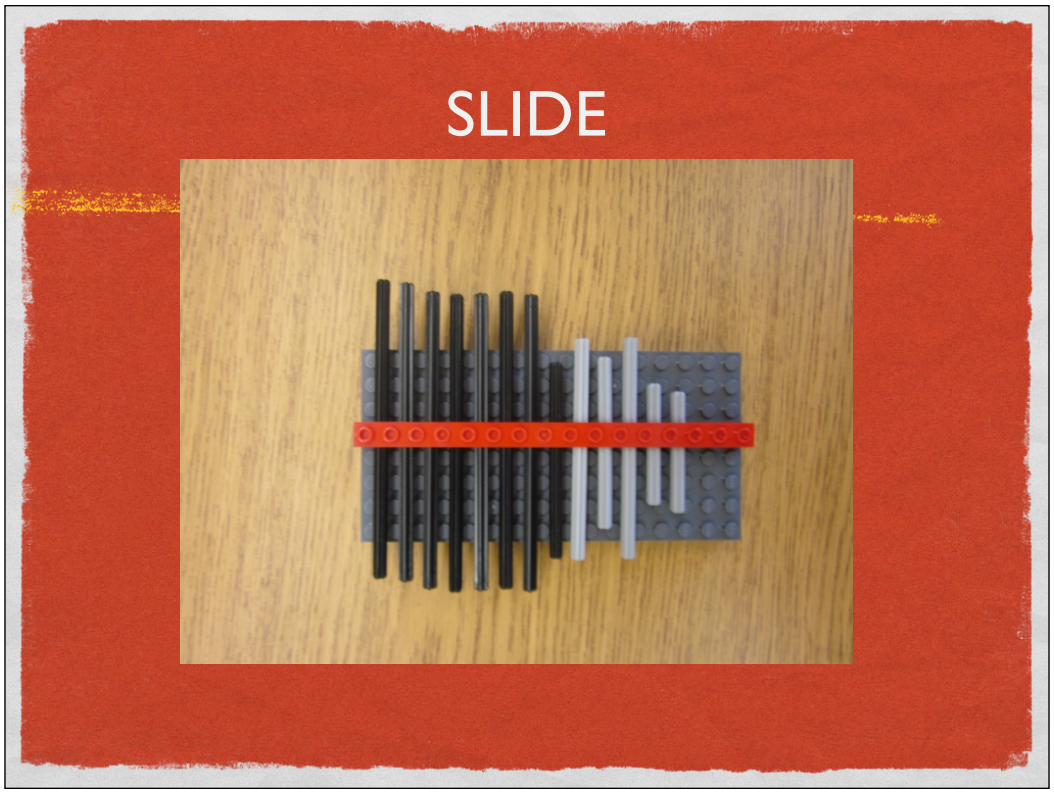
MERRY GO ROUND

Ella

FERRIS WHEEL

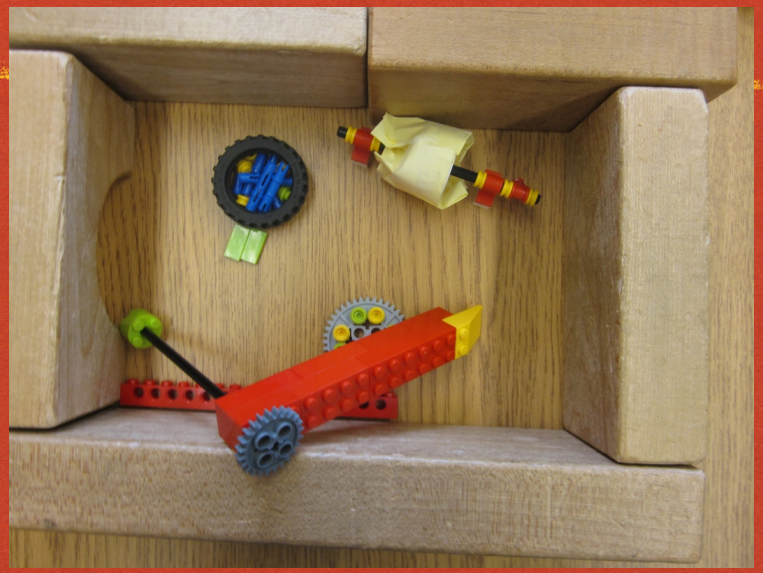


John

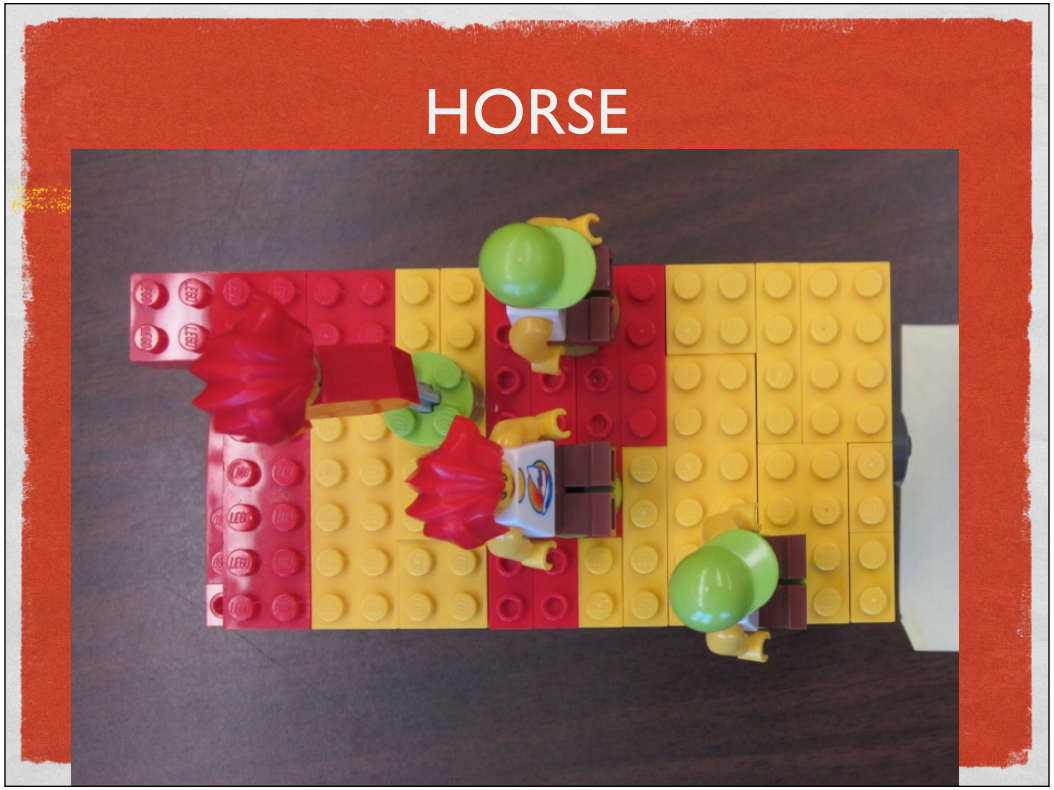


Jesse

PARK

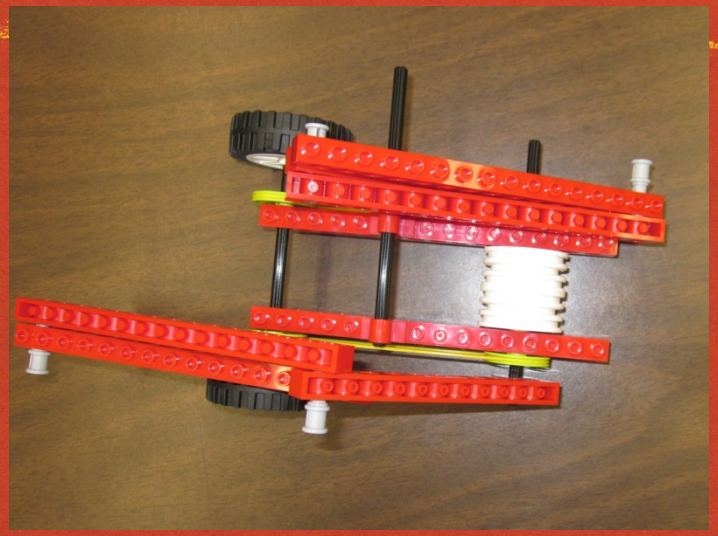


Nicky



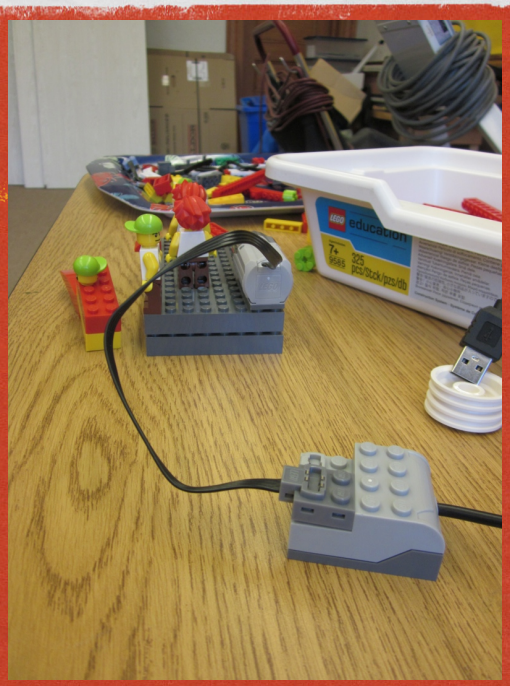
Aly

RIDE WITH CRANE



Reid

FUN HOUSE



Ada

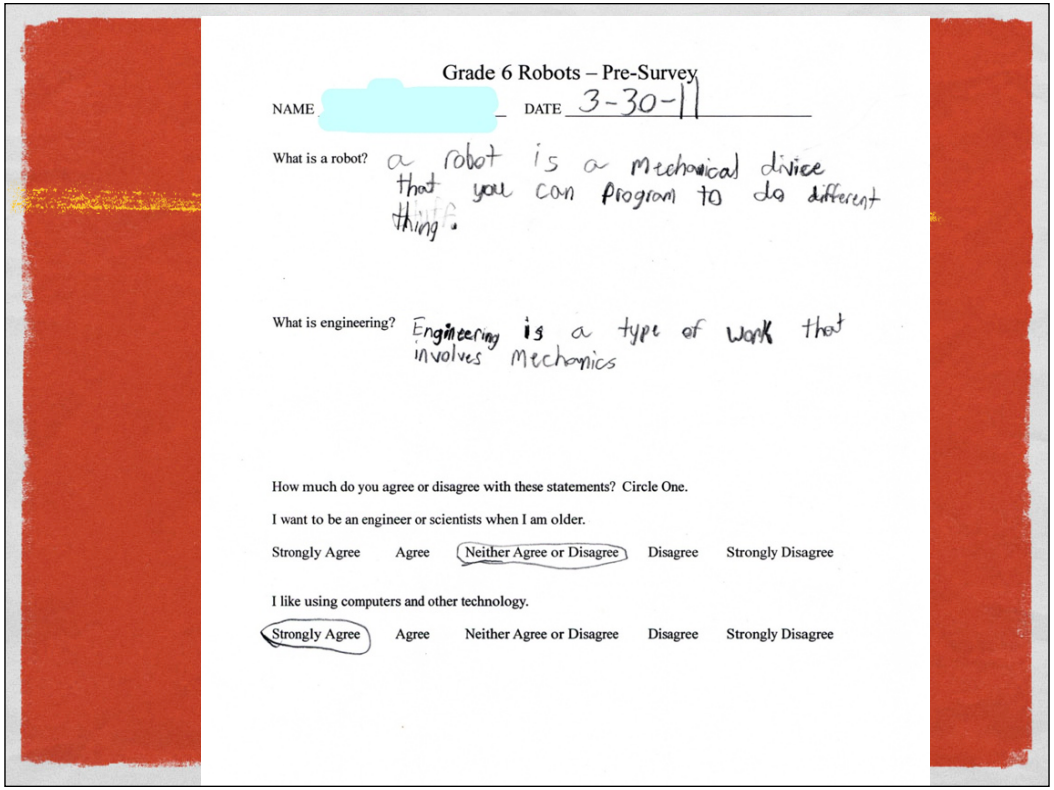
RIDE LINE

Daniel

Mavis

K OBSERVATIONS

- Use of LEGO in 7 of 9 cases
- Fine motor skills
- Many were eager to use computers even though not taught yet
- Self-talk
- Range of products



Grade 6 Robots – Pre-Survey

NAME [redacted] DATE 3-30-11

What is a robot? a robot is a Mechanical divice that you can Program to do different thing.

What is engineering? Engineering is a type of work that involves Mechanics

How much do you agree or disagree with these statements? Circle One.

I want to be an engineer or scientists when I am older.

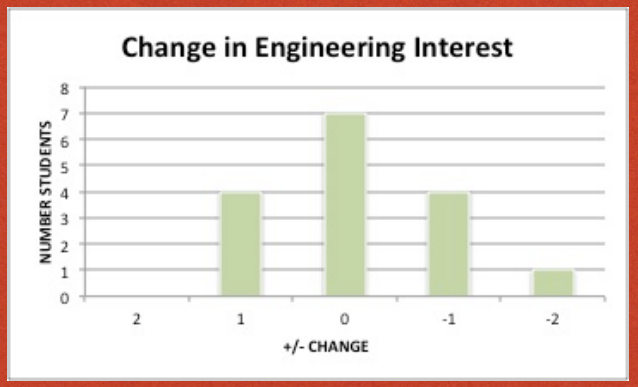
Strongly Agree Agree (Neither Agree or Disagree) Disagree Strongly Disagree

I like using computers and other technology.

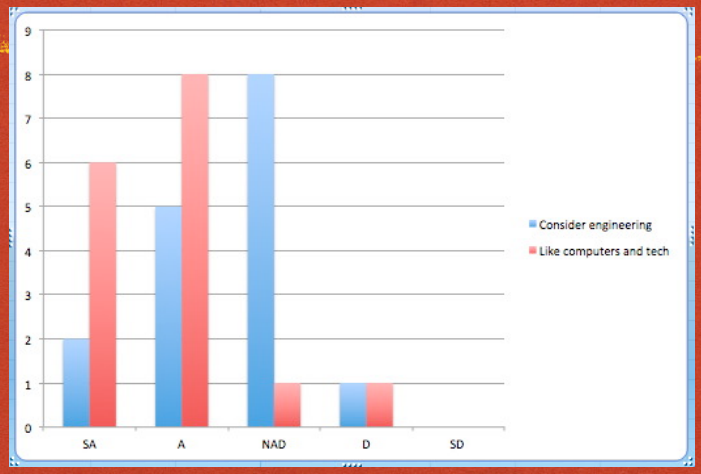
(Strongly Agree) Agree Neither Agree or Disagree Disagree Strongly Disagree

Want to move the first question to the left so kids are not just consumers.

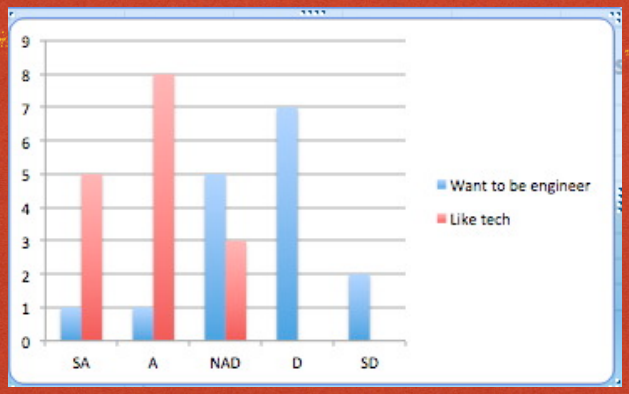
GRADE 6 2011 CHANGE



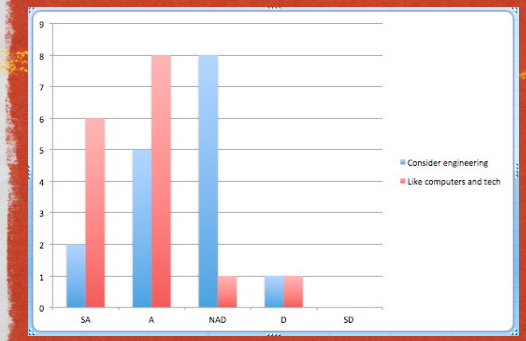
GRADE 6 2012 SURVEY

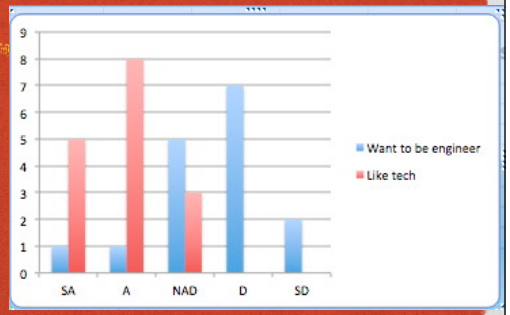


G6 2011 SURVEY



COMPARISION





TEACHER INTERVIEW

OTHER RESEARCH

- 3 Types of Papers: descriptive, studies, reviews
- Much of the focus has been on high school/middle school and using engineering education to teach science
- All approaches constructivist and constructionist (some newer papers integrate standards based)

Leonard, M. J., & Derry, S. J. (2011). WCER Working Paper No. 2011-5. Retrieved from http://widaredesign.wceruw.org/publications/workingPapers/Working_Paper_No_2011_05.pdf

Science and engineering distinct but interacting fields.

Don't underestimate the complexity of supporting science learning via design.

Implications: a study of how math, science, engineering, and technology all interact in robotics based engineering education would be interesting and new.

Brophy, Sean, Portsmore, Merredith, Klein, Stacy, & Rogers, Chris. (2008). Advancing Engineering Education in P-12 Classrooms. Journal of Engineering Education, 97(3).

Good review of current and past efforts in P-12 engineering education.

Discusses the need for young learners to experience engineering, the need for a STEM pipeline, and the need for and possible directions for future research.

Puntambekar, A & Kolodner, J (2005). Distributed Scaffolding: Helping Students Learn Science from Design.

Multiple means of scaffolding needed to support the learning of science concepts through design.

Crismond, D. (2001). Learning and using science ideas when doing investigate-and-redesign tasks: A study of naive, novice, and expert designers doing constrained and scaffolded design work. Journal of Research in Science

> Non-expert designers did not use general science concepts to help with their designs.

A lot of work is focused on the learning of science concepts (abstract) at middle and high school via design. With elementary engineering, where abstract thinking is less developed, do we have the same goal? Are things fundamentally different or just scaled down? If younger students do not have general content knowledge, what is the value? Affective? Creativity? Engineering design process? STEM interest? Or do elementary hands on activities help develop general content knowledge?

Resources

- jheffernan@hr-k12.org
- http://www.kidsengineer.com/

MATIERIALS LIST

- WeDo Kits (5)
- Dancing Birds Handouts (10)
- Ride Challenge Handout
- Reflection Handout (10)
- Laptops (5)
- Presentation, bibliography, handouts (post online?)
- Laptop, video adaptor, power cord, mouse, speakers (?)
- Snack