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Scaffolding Wearable-Based Scientific Inquiry for Early Learners



#1441184



Wearable-Based Inquiry (WBI)

Upper elementary & middle school learners

equipped with wearable sensors

can conduct life-relevant experiments with

their own bodies (Lee, Drake, Williamson, 2015; Schaefer, Carter Ching, Breen, & German, 2016) and

within school routines (Lee & Thomas, 2011; Lee, Drake, Cain, & Thayne, 2015)



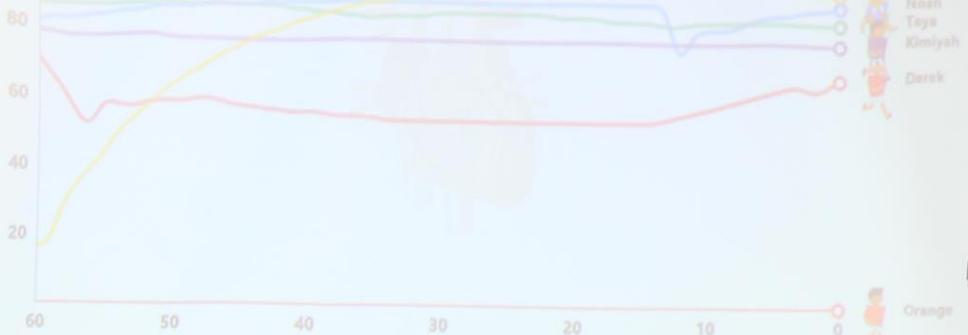


Supporting Early Learners

Vocabulary



Student Work



A classroom scene with three young students in the foreground. A boy in the center has his hand raised. A girl on the right also has her hand raised. In the background, a large screen displays a line graph with five lines of different colors (red, yellow, blue, purple, green) and a legend on the right side. The graph shows data points for five individuals: Kerra, Noah, Kimlyah, Derek, and Orange. The x-axis is labeled from 60 to 0, and the y-axis is labeled from 20 to 80. The word "Scaffolding" is written in large white letters across a semi-transparent red banner in the middle of the image.

Scaffolding

Scaffolding enables learners to reach tasks they could *not* independently achieve

(Wood, Bruner & Ross, 1976; Carter-Ching & Kafai, 2008; Hmelo, Holton, & Kolodner, 2000; Reiser & Tabak, 2014)



BodyVis: A model-based representation

Norooz et al., 2015; Norooz et al., 2016

SharedPhy
S

An analytic
representation

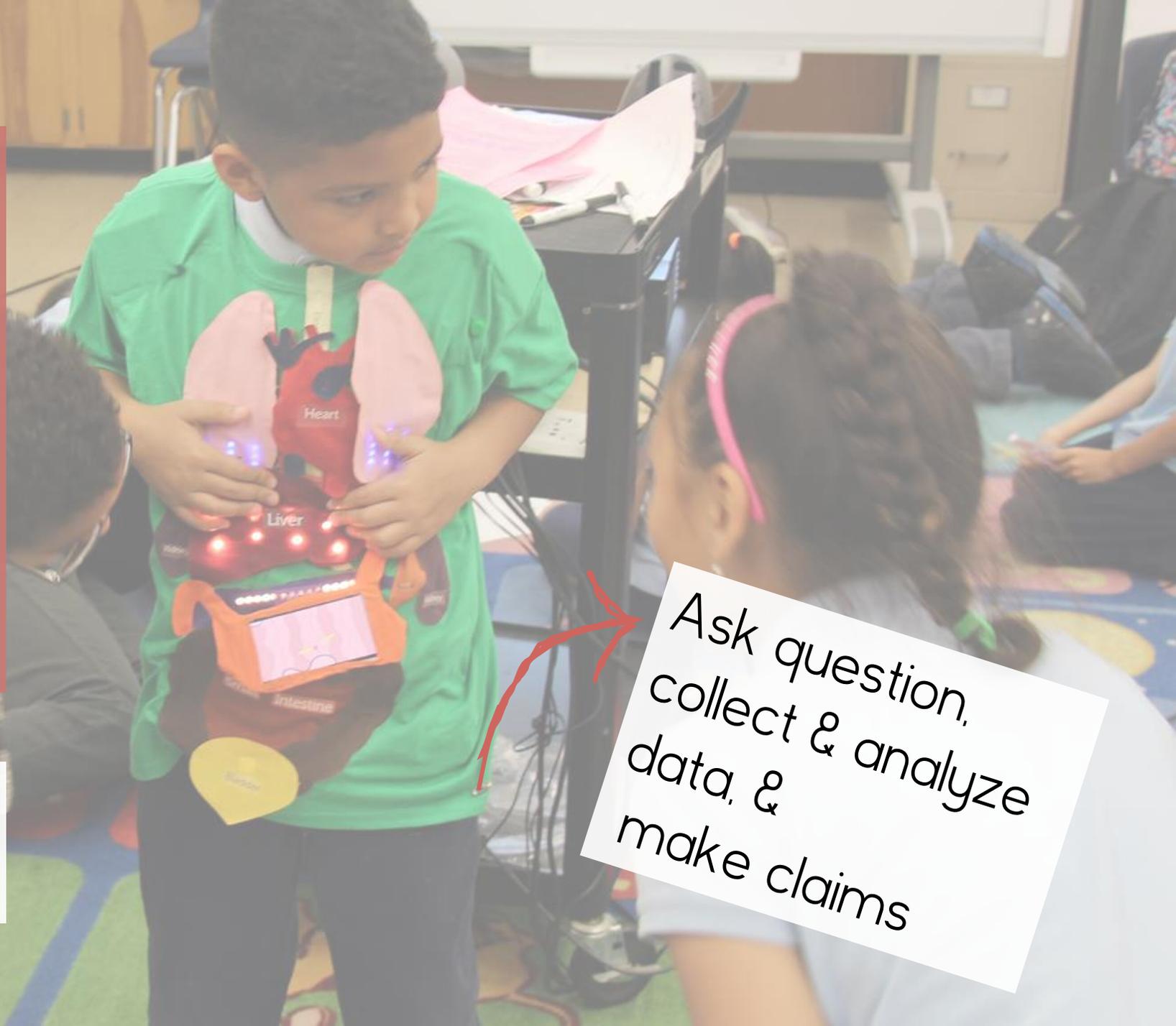
Kang et al., 2016

Moving Graphs

Leveraging the Body as a Platform for

Inquiry

Embodied Learning
Approach (Lee, 2015)



Ask question,
collect & analyze
data, &
make claims

Research Questions

How do scaffolds impact the authenticity of children's scientific WBI across grade levels?

How can we design multi-dimensional scaffolds for WBI that integrates technology tools, peers, facilitators, and paper-based materials?



Iterative Process of Developing Scaffolds

Year
1



Co-Design Sessions with
Teachers & Children



Year
2



Iterative Process of Developing Scaffolds

Year
1



Co-Design Sessions with Teachers & Children



Year
2



In-Class Deployment



Iterative Process of Developing Scaffolds

Year
1

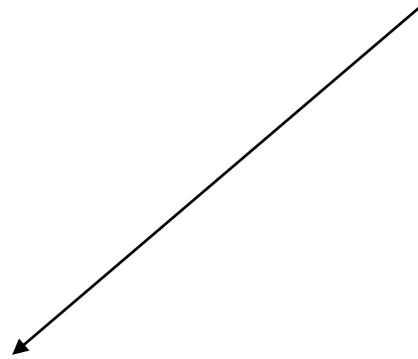


Co-Design Sessions with Teachers & Children

Year
2



Co-Design Session with Teachers



In-Class Deployment



Iterative Process of Developing Scaffolds

Year
1



Co-Design Sessions with Teachers & Children

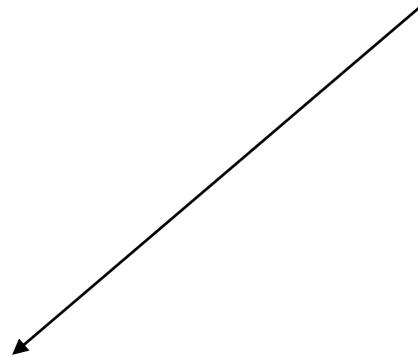


In-Class Deployment

Year
2



Co-Design Session with Teachers



In-Class Deployment

Four, One-Hour, In-Class sessions

Year 1: Spring 2016

Year 2: Spring 2017

1st Grade and 4th Grade Classrooms

Same teachers each year



Washington, DC Area Public Elementary

68% African American

23% Hispanic or Latino/a

4% Multi-Racial

3% Asian or Asian American

2% White

65.6% Qualify for free/reduce-priced meals

Across our first & fourth-grade classrooms

45 children participated in 2016

45 children participated in 2017



Day 1: Play and Discovery

Children **discussed questions** about anatomy and physiology and engaged in **free-form exploration** with the tools' heart and breathing rate functions in a scavenger hunt.



Day 2: Exploring Physical Activities

Children **brainstormed physical activities** with BodyVis. They then **tested their hypotheses** with SharedPhys.



Day 4: Presentations

Children conducted their experiment, interpreted results, and presented findings to the class.



Life Relevant Scientific Inquiry

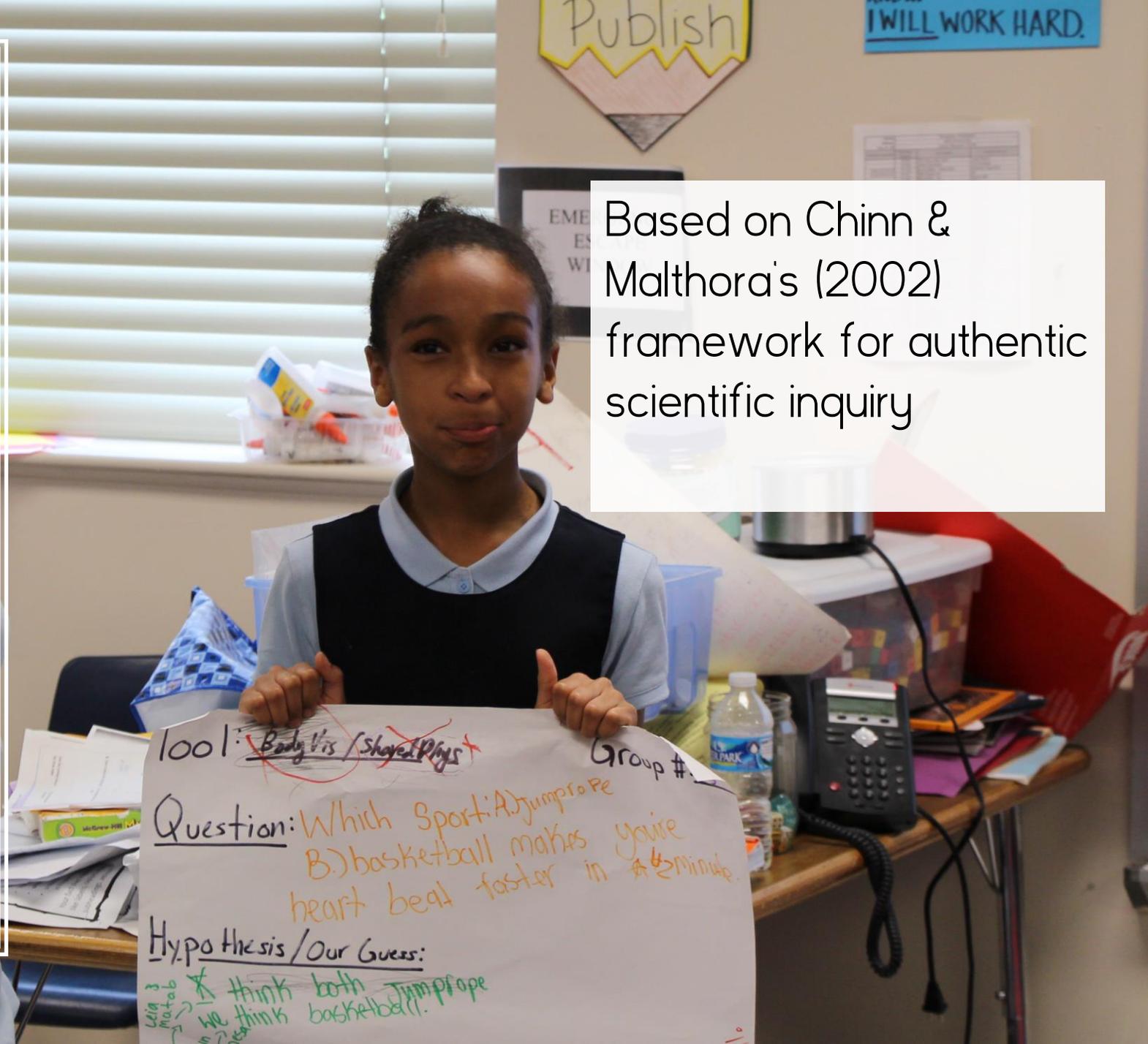
Learners are free to ask questions that are:

Of interest,

Related to daily activities,
and

Leverage their pre-existing
knowledge.

Based on Chinn & Malthora's (2002) framework for authentic scientific inquiry



Topic: ~~Body Vis / Shared Phys~~
Group #:
Question: Which Sport: A) jump rope
B) basketball makes your
heart beat faster in 1/2 minute.
Hypothesis / Our Guess:
* think both jump rope
we think basketball.

How does my heart rate change when I laugh?

How does my heart rate change when I do the Nae Nae?

How does my heart rate change when I do the Carlton?

What increases the heart rate more: galloping or chilling?

What happens to her heart rate when she gets scared?



Data Collection & Case Studies

Year 1 and Year 2 Case Structure

Three 1st Grade Groups

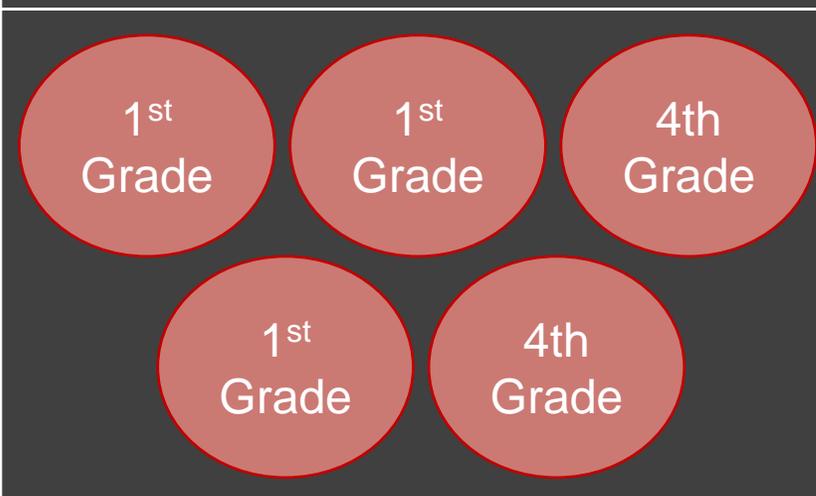
Two 4th Grade Groups

4 – 7 kids per group

YEAR 1



YEAR 2

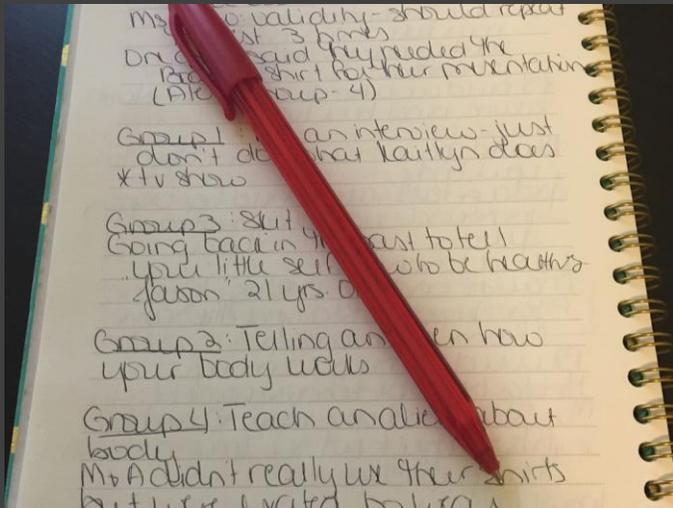




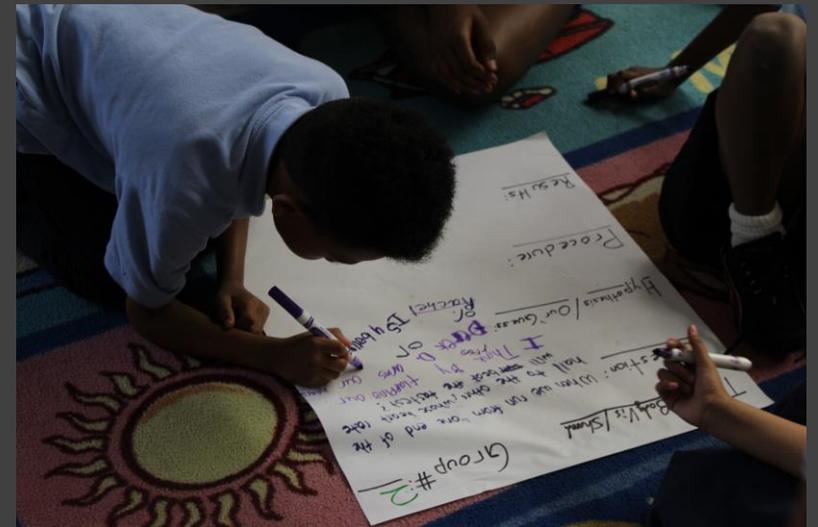
Video Data
& Photographs



Teacher Interviews

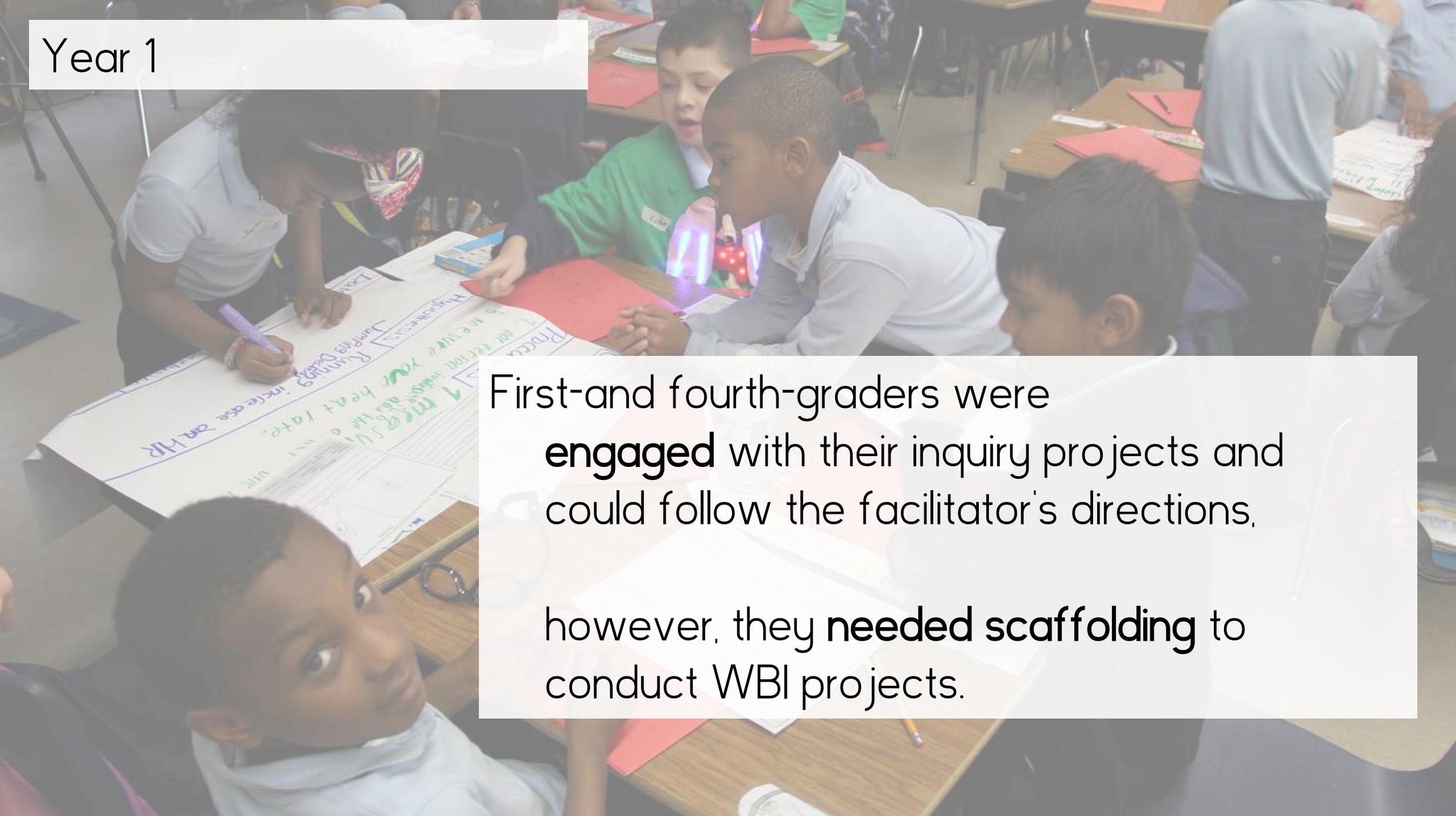


Facilitator Post
Observation Field
Notes



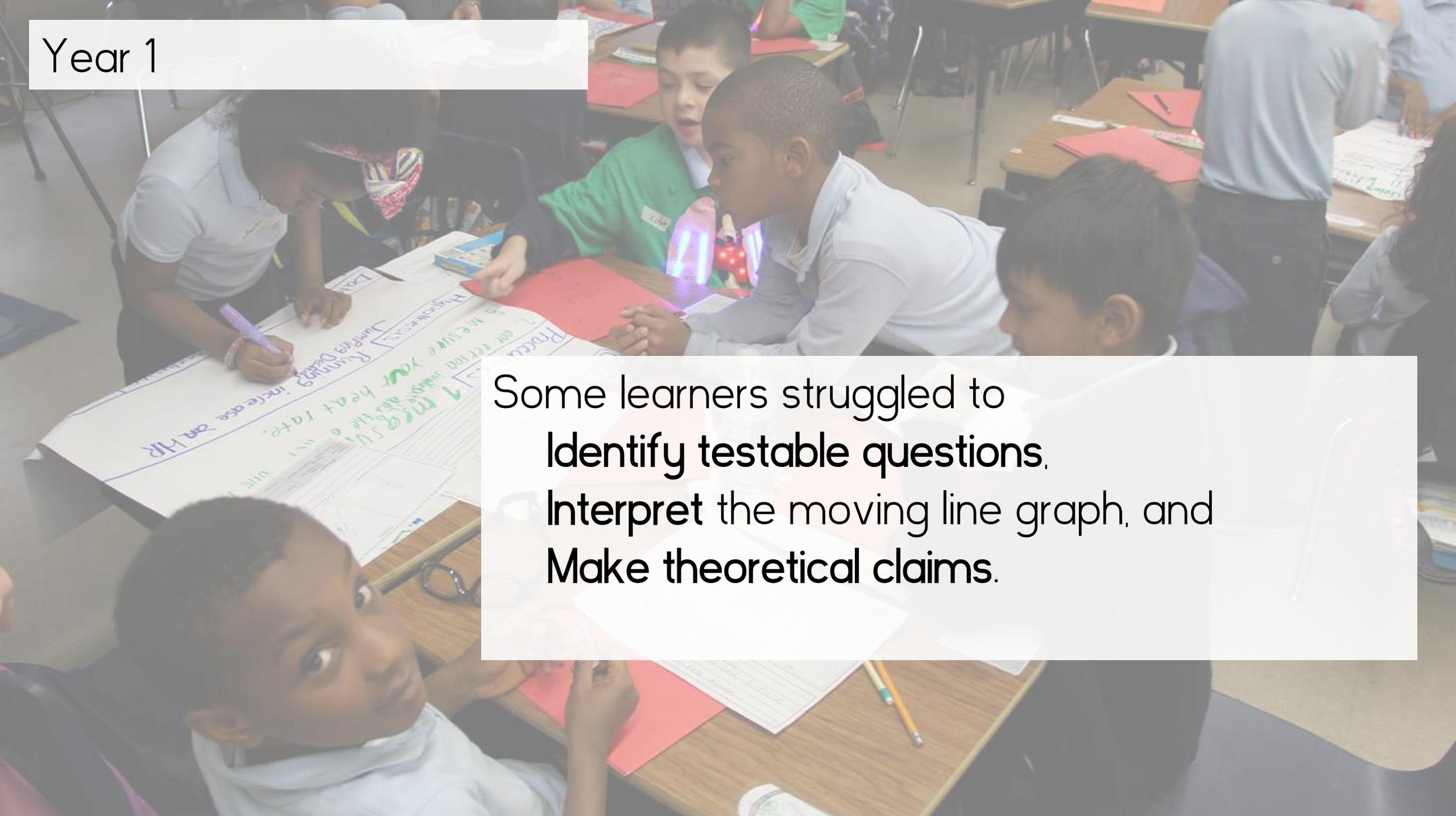
Inquiry Project
Artifacts

Year 1



First-and fourth-graders were **engaged** with their inquiry projects and could follow the facilitator's directions, however, they **needed scaffolding** to conduct WBI projects.

Year 1

A group of Year 1 students are gathered around a table in a classroom, working on a science project. They are looking at a large sheet of paper with handwritten notes and a line graph. One student is writing on the paper with a purple marker. The graph shows a line that starts at the origin and curves upwards, with the label 'heat rate' written next to it. The students are dressed in school uniforms. The classroom background shows other students at their desks, some of whom are also working on projects.

Some learners struggled to
Identify testable questions,
Interpret the moving line graph, and
Make theoretical claims.

Year 2 Scaffolds

Constrained research questions to a set of **testable criteria**.

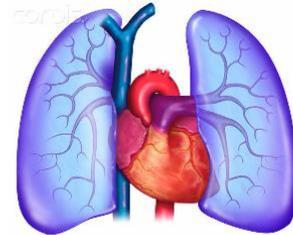
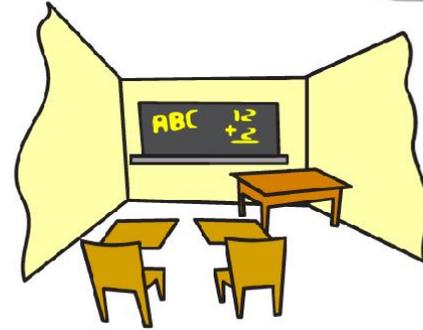
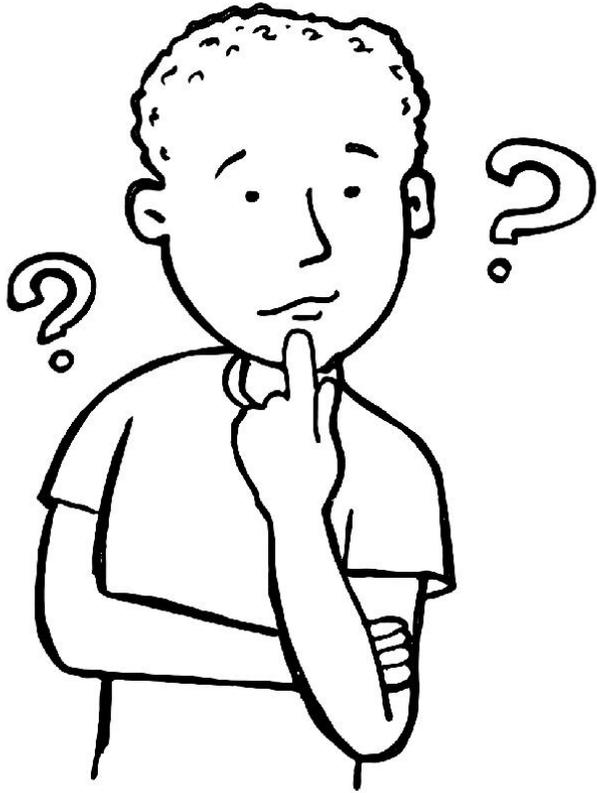
Provided **vocabulary definitions** for language to express ideas in a testable frame.

Provided **grade-specific writing activities** to aid idea expression & procedural thinking.

Provided opportunities to **practice prediction** and interpreting line graphs

Provided a **synthesis of results** across groups for collective understanding and building theory

Testable Questions



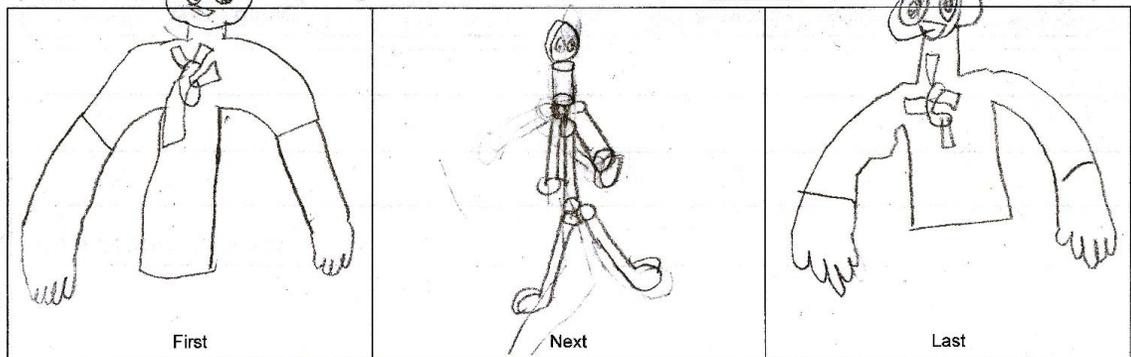
First-Grade Three-Panel Worksheet

Name: _____ Scientific Process _____ BodyVis Day 3

My Scientific Question (from Day 2):

Will my heart rate increase if I do the max hop?

1) Procedures: Draw the steps for your experiment. Include all of your materials in your drawings.



2) Procedures. Now write the Steps

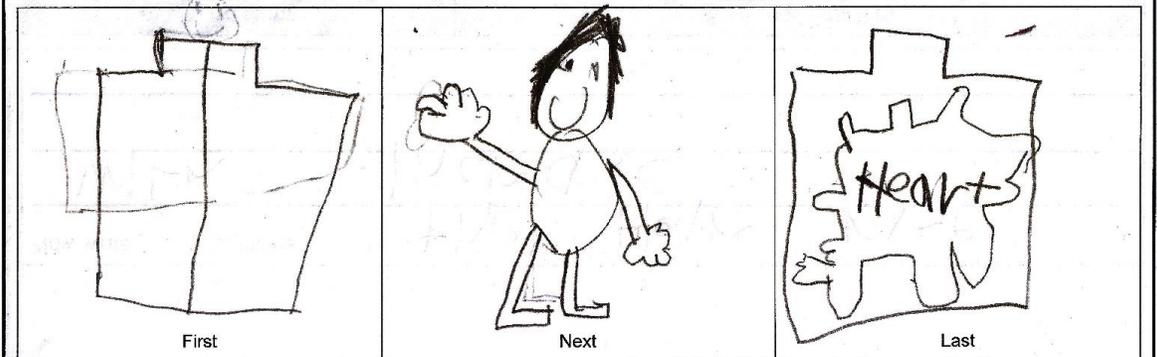
check his/her heart rate before do the max hop. check the heart rate again if the heart rate increase or decrease.

Name: _____ Scientific Process _____ BodyVis Day 3

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1) Procedures: Draw the steps for your experiment. Include all of your materials in your drawings.



2) Procedures. Now write the Steps

check the heart rate do the max hop check the heart rate again



Running
vs
Jump
Dancing

there
time
the

Visual Repository of Experiment Results

Physical Activity	Heart Rate Start → Finish
TAG	
RUNNING FAST MAX	125bpm → 160bpm
FROG JUMP	
SKI JUMP Caleb	140bpm → 150bpm
JUMPING JACKS	
PUSH UPS charc	120bpm → 150bpm

Test	Conclusion
Galloping VS. Chill	Galloping increases heart rate Chilling made heart rate ^{stay the} same
Dang Homework	Homework makes heart rate stay the same
Jumping high	Increased
Running VS Jumping	→ Running increased <u>less</u> than jumping
Dancing	

Year 2 Scaffolds



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Provided opportunities to practice prediction and interpreting line graphs

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Future
Research

The BodyVis Team



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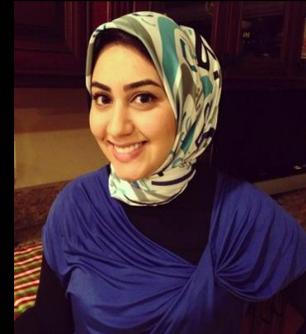
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