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Scaffolding Wearable-Based Scientific Inquiry for Early Learners

UNIVERSITY OF
MARYLAND



#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).

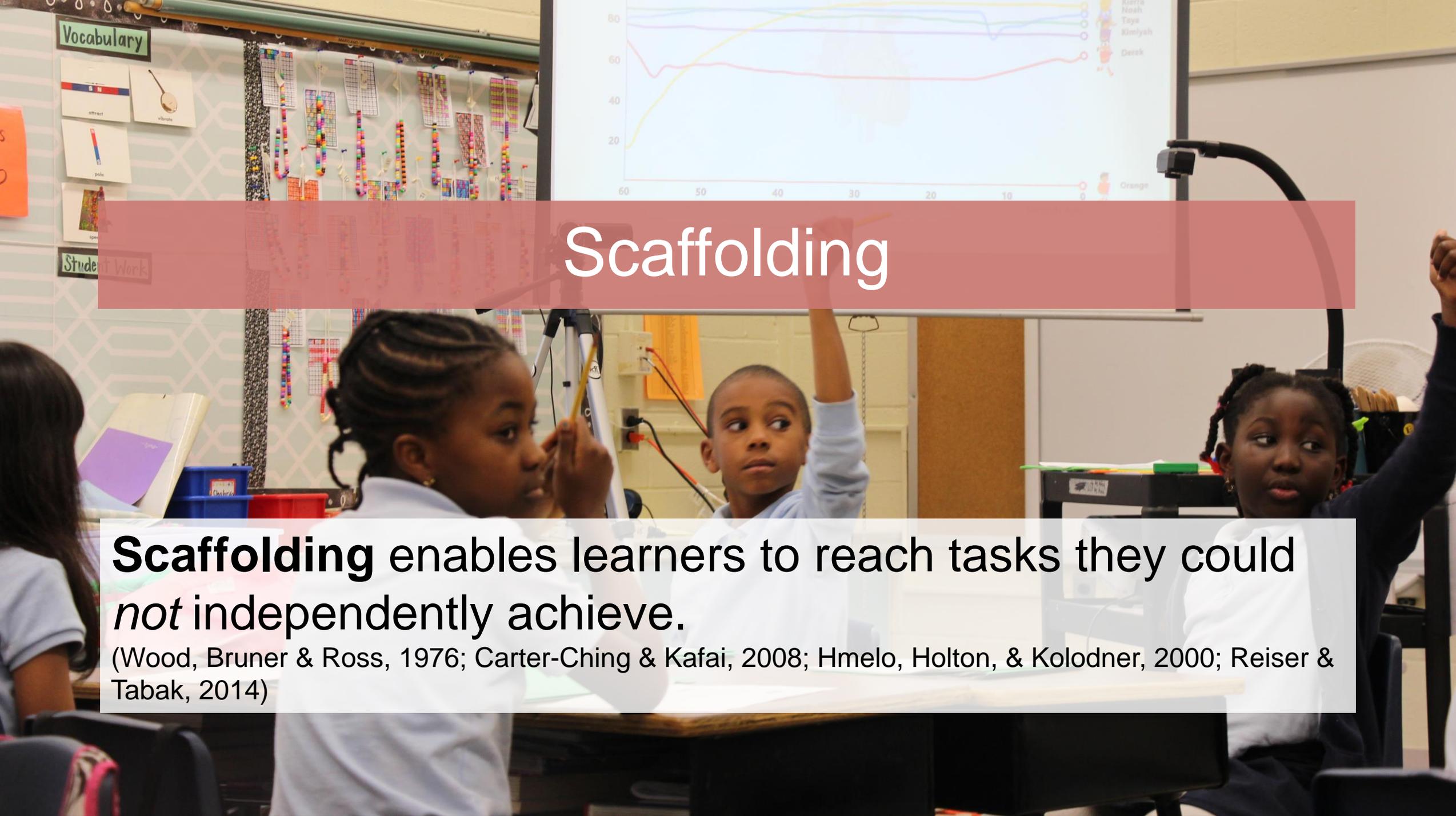




Supporting Early Learners

First Graders: 6 – 7 years old

Fourth Graders: 9 – 10 years old

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 data series. The graph's x-axis is labeled from 60 to 0, and the y-axis is labeled from 20 to 80. The legend on the right lists names: Kierri, Noah, Tays, Kimlysh, Derek, and Orange. The graph shows various trends, with some lines rising and others falling. To the left of the screen, a bulletin board is visible with a 'Vocabulary' section containing words like 'attract' and 'vibrate', and a 'Student Work' section with colorful beadwork.

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)

Two Wearable Sensing Tools





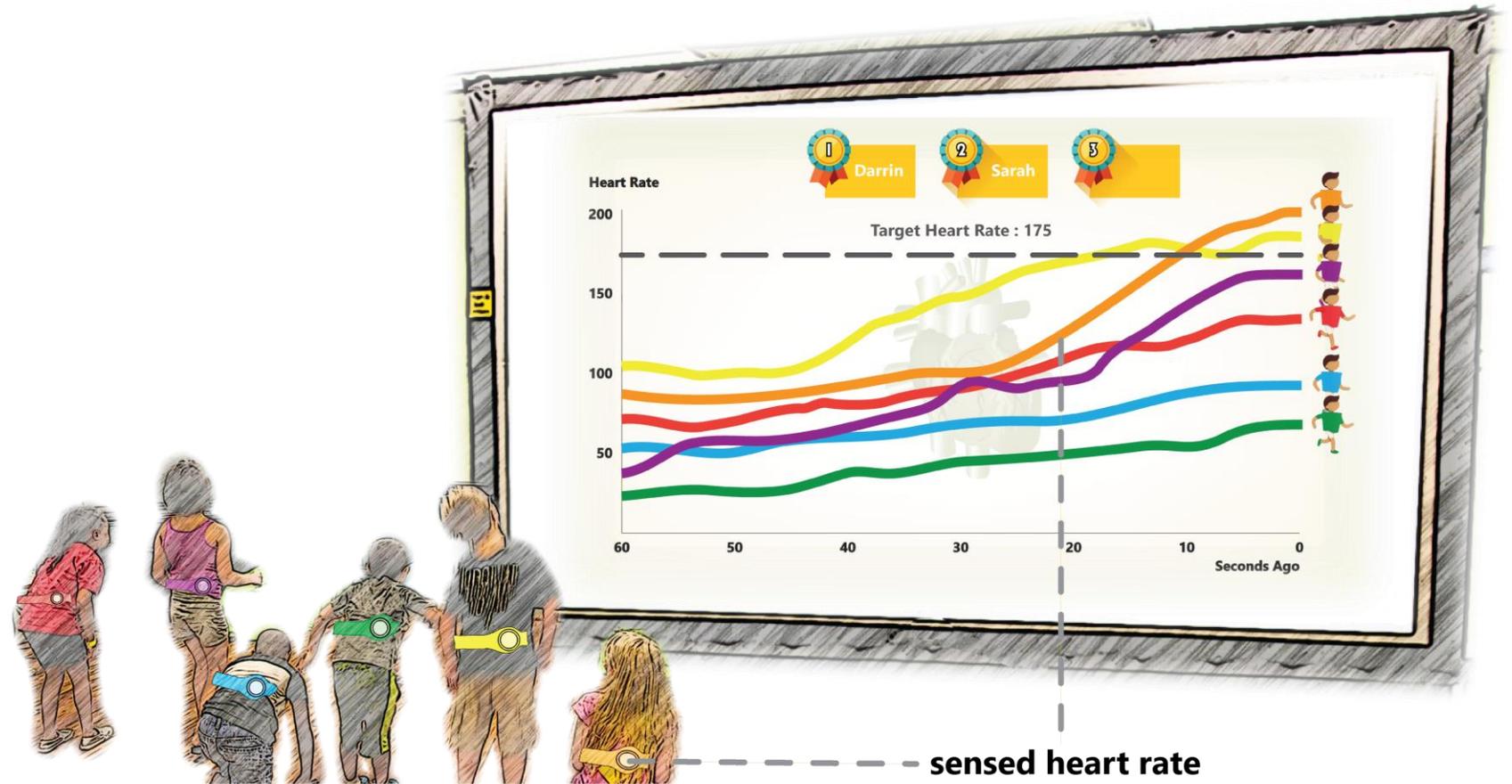
BodyVis: A model-based representation

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

SharedPhys

An analytic representation

Kang et al., 2016



SharedPhys

An analytic
representation

Kang et al., 2016

Moving Graphs

Leveraging the Body as a Platform for Inquiry

Embodied Learning
Approach (Lee, 2015)

Enable kids to
ask questions,
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



In-Class Deployment

Year 2



Iterative Process of Developing Scaffolds

Year 1



Co-Design Sessions with Teachers & Children

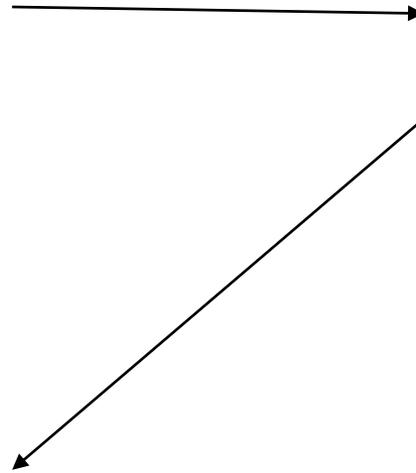


In-Class Deployment

Year 2



Co-Design Session with Teachers



Iterative Process of Developing Scaffolds

Year 1



Co-Design Sessions with Teachers & Children



In-Class Deployment

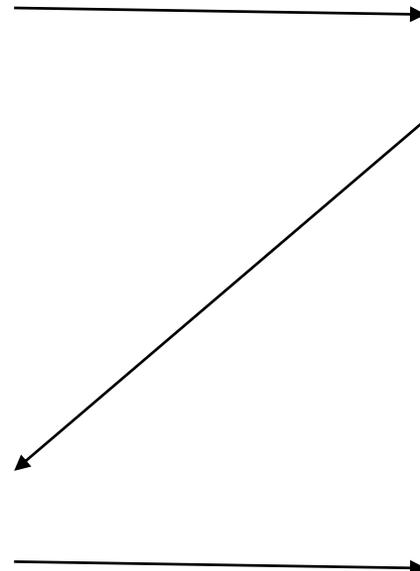
Year 2



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 or reduce-priced meals

Across our first & fourth-grade classrooms

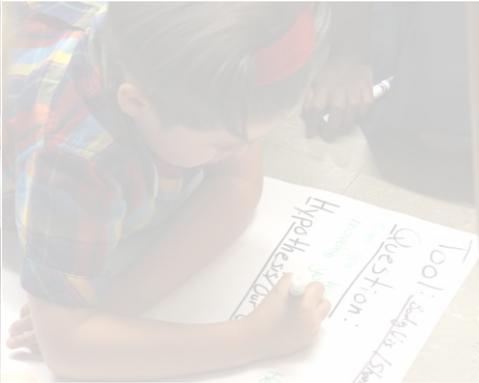
45 children participated in 2016

45 children participated in 2017



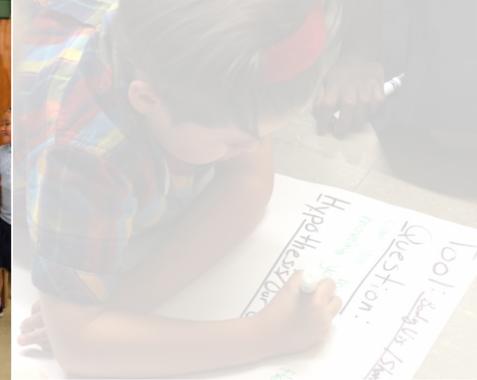
Day 1: Play and Discovery

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.



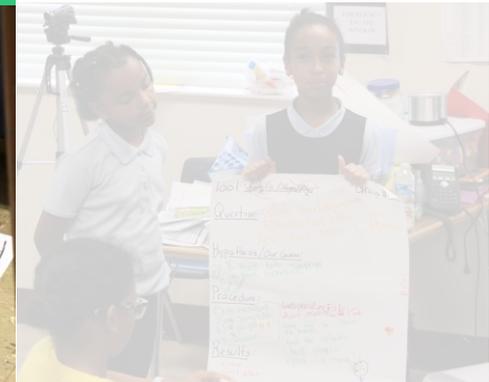
Day 2: Exploring Physical Activities

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



Day 3: Science Experiments

Children planned scientific investigations of their choosing with **BodyVis** or **SharedPhys**.



Day 4: Presentations

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



Life Relevant Scientific Inquiry

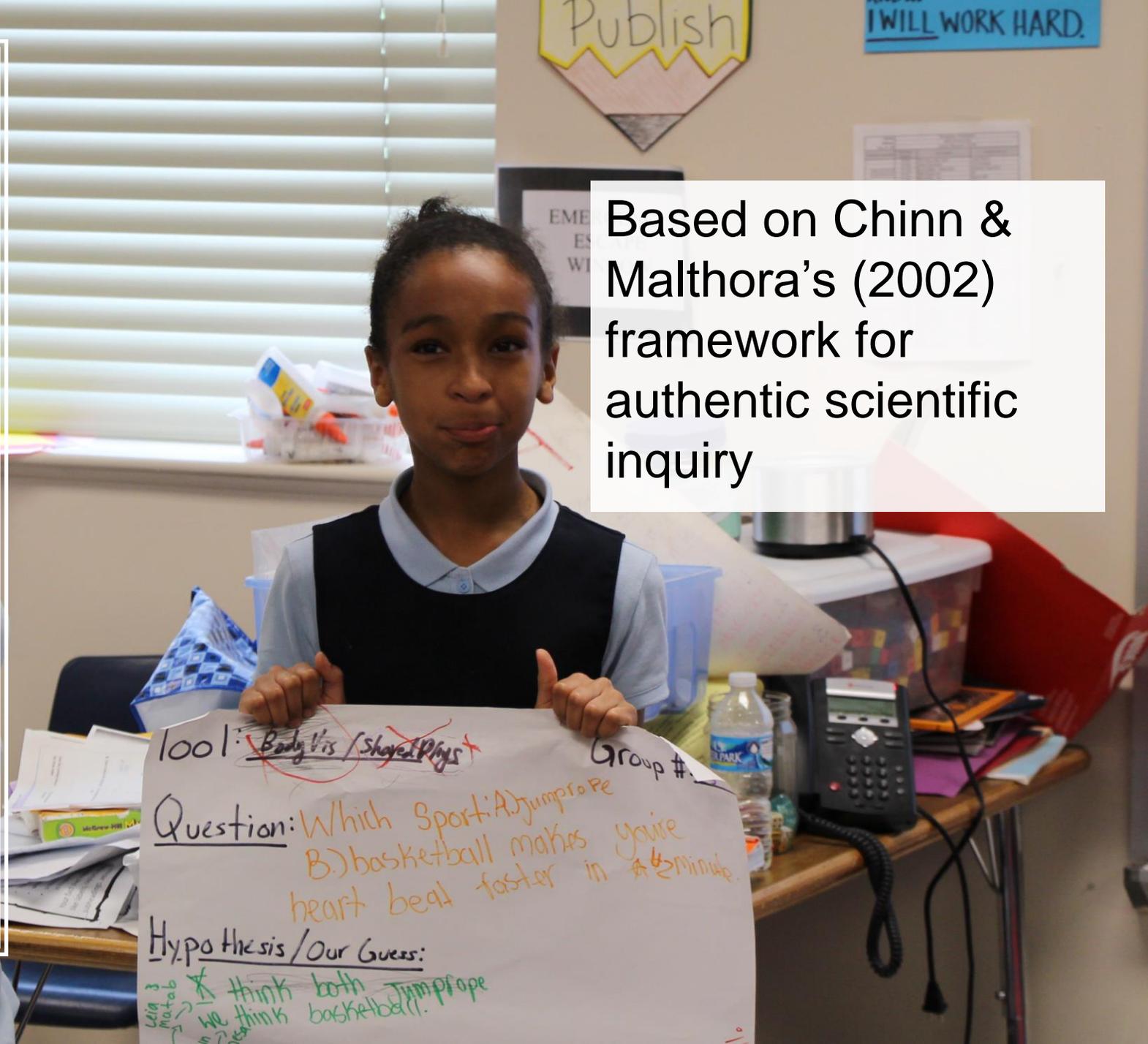
Learners are free to ask questions that are:

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~~ 4 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

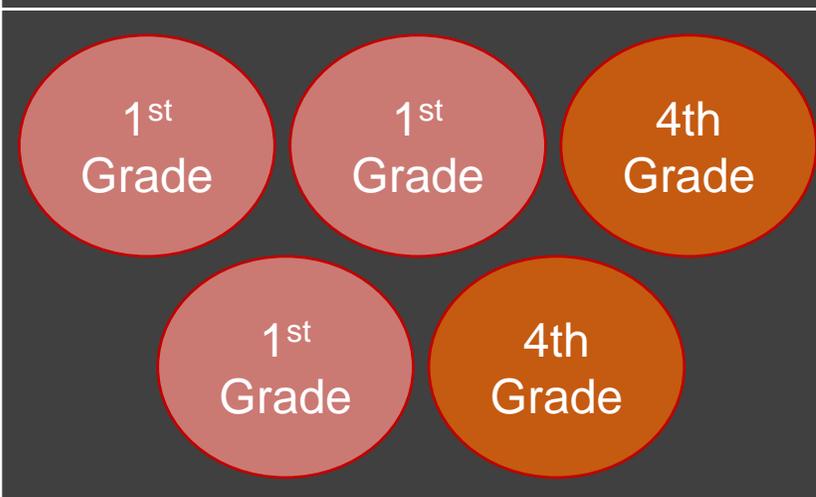
Three 1st Grade Groups
Two 4th Grade Groups

4 – 7 kids per group

YEAR 1



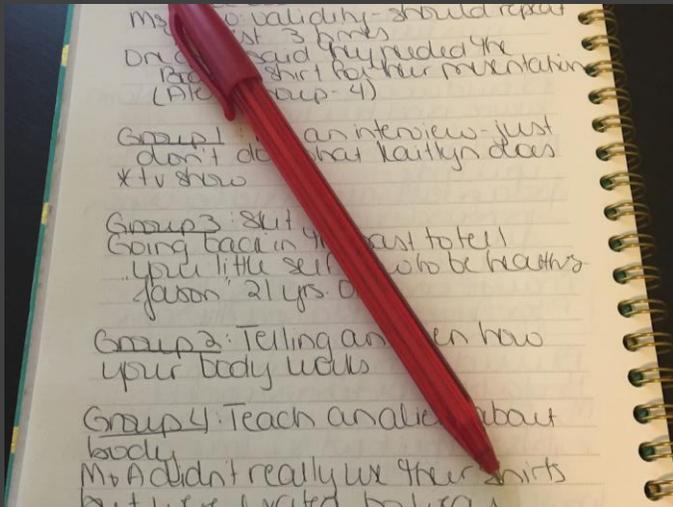
YEAR 2





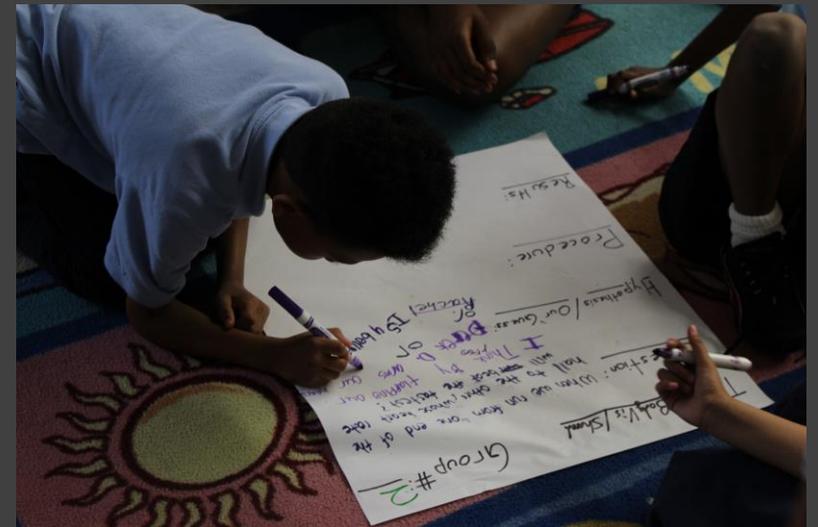
Video Data
& Photographs

Teacher Interviews

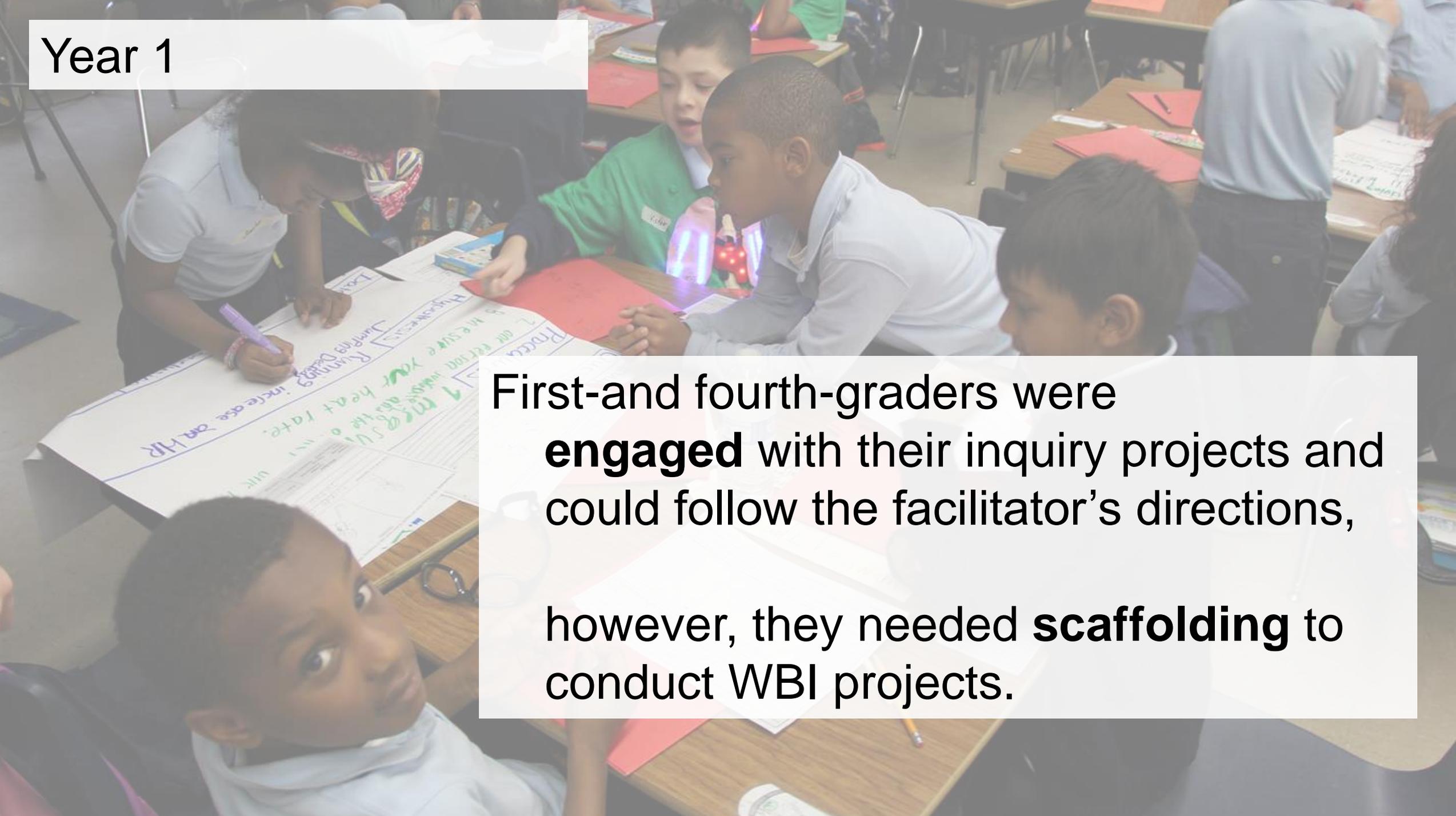


Facilitator Post
Observation
Field Notes

Inquiry Project
Artifacts

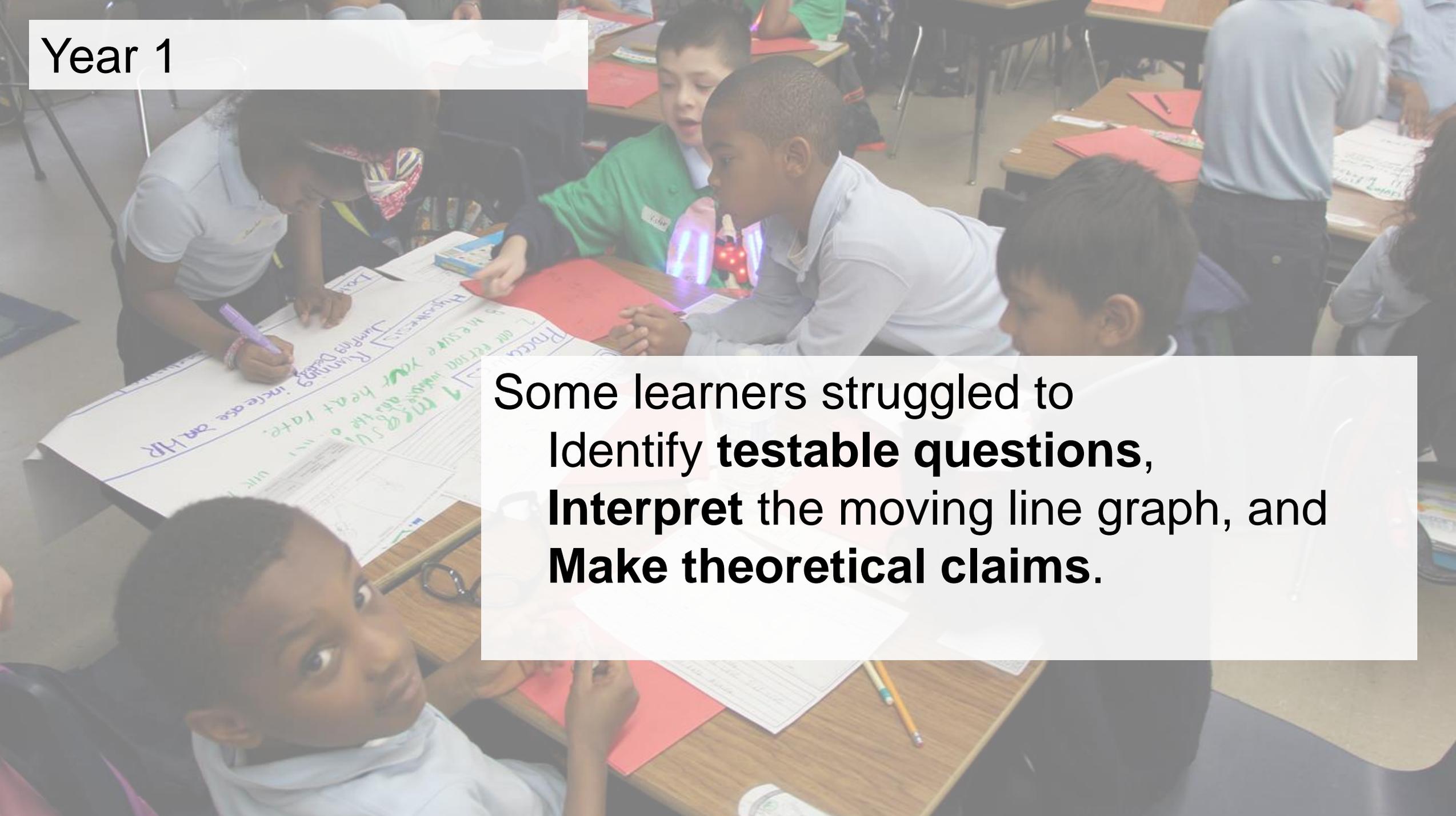


Year 1



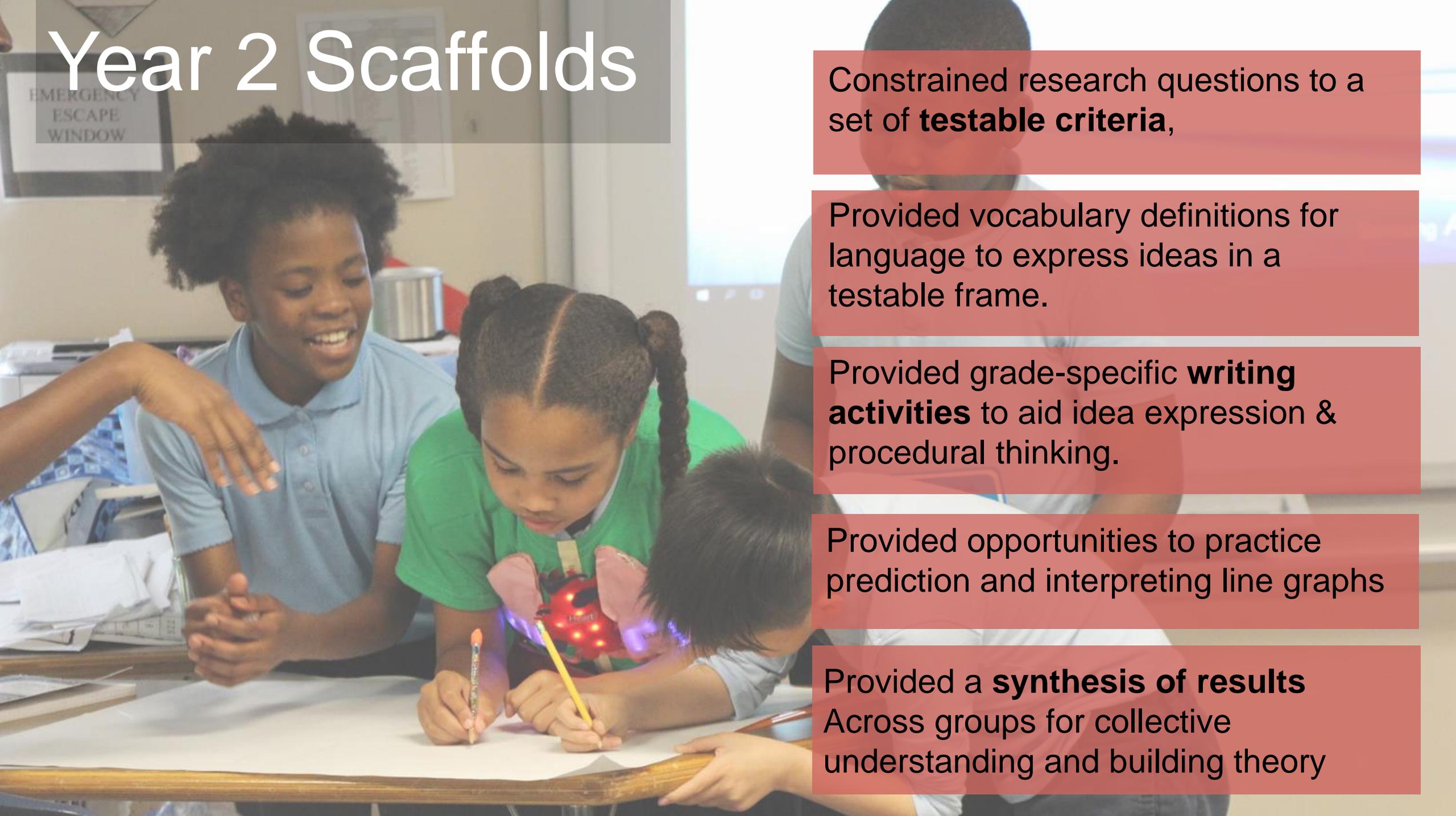
First-and fourth-graders were **engaged** with their inquiry projects and could follow the facilitator's directions, however, they needed **scaffolding** to conduct WBI projects.

Year 1

A group of Year 1 students are gathered around a table in a classroom, working on a project. They are looking at a large sheet of paper with handwritten text and a line graph. One student is writing on the paper with a purple marker. Another student is pointing at the graph. The paper has the following text: "Hypothesis: Running during winter increases the rate of heat loss." and "Prediction: The rate of heat loss will increase during winter." The graph shows a line that starts at a low point and rises steadily. The text "1 m/s" is written on the graph. The students are wearing school uniforms. The classroom has desks and chairs, and other students are visible in the background.

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**,

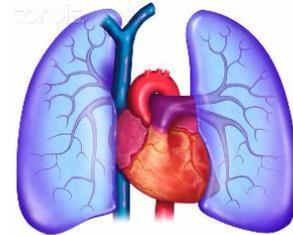
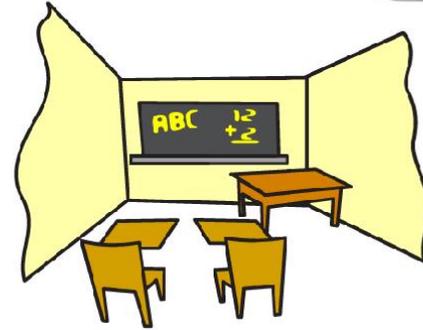
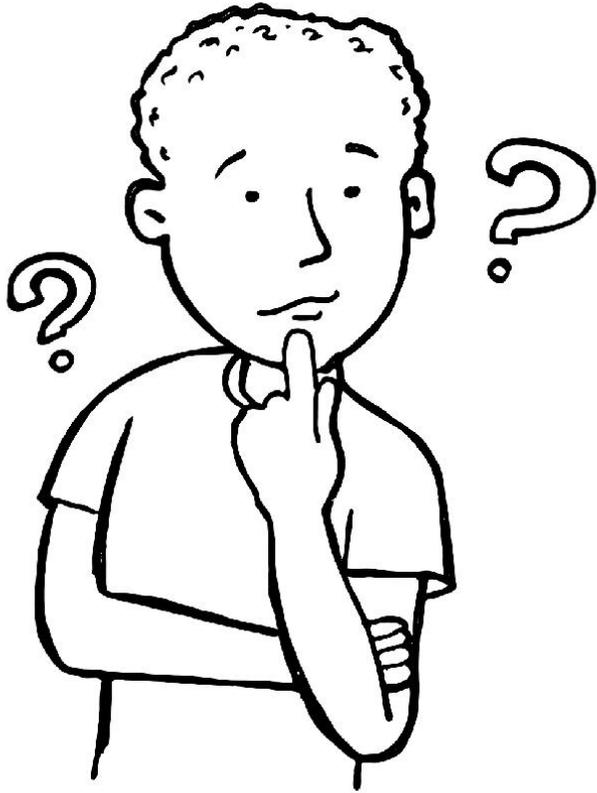
Provided vocabulary definitions for language to express ideas in a testable frame.

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



Nae Nae Dance



 **LiveSlides** web content

To view

Download the add-in.

liveslides.com/download

Start the presentation.

Nae Nae Dance

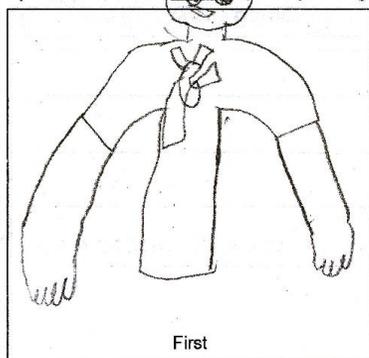
First-Grade Three-Panel Worksheet

Name: _____ Scientific Process _____ BodyVis Day 3

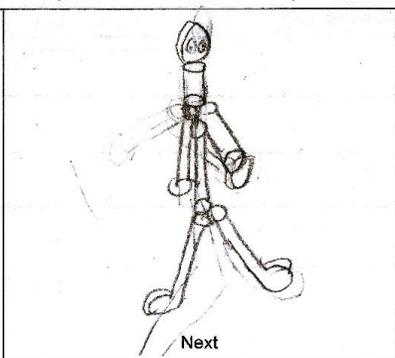
My Scientific Question (from Day 2):

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

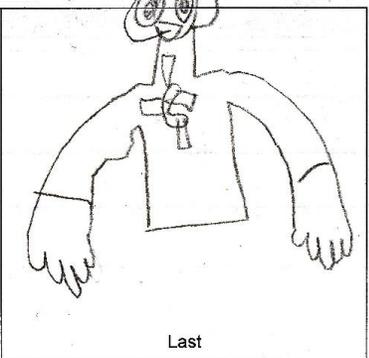
1) Procedures: Draw the steps for your experiment. Include all of your materials in your drawings.



First



Next



Last

2) Procedures. Now write the Steps

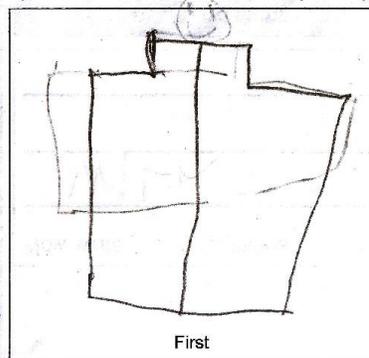
check his/her heart rate. before do the max hop. check the heart rate again if the heart rate increase or decrease.

Name: _____ Scientific Process _____ BodyVis Day 3

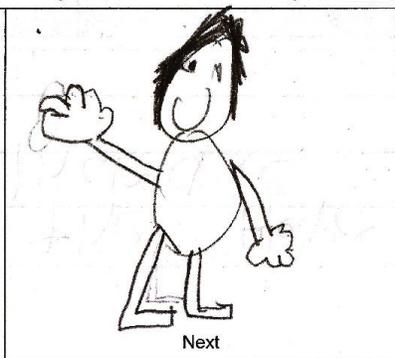
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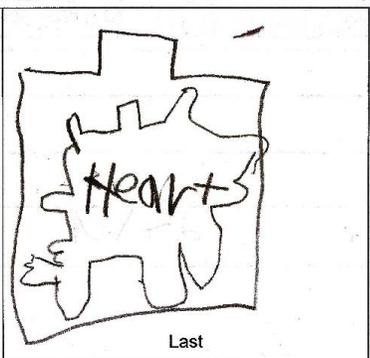
1) Procedures: Draw the steps for your experiment. Include all of your materials in your drawings.



First



Next



Last

2) Procedures. Now write the Steps

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



Running
vs
Jump

Dancing

There

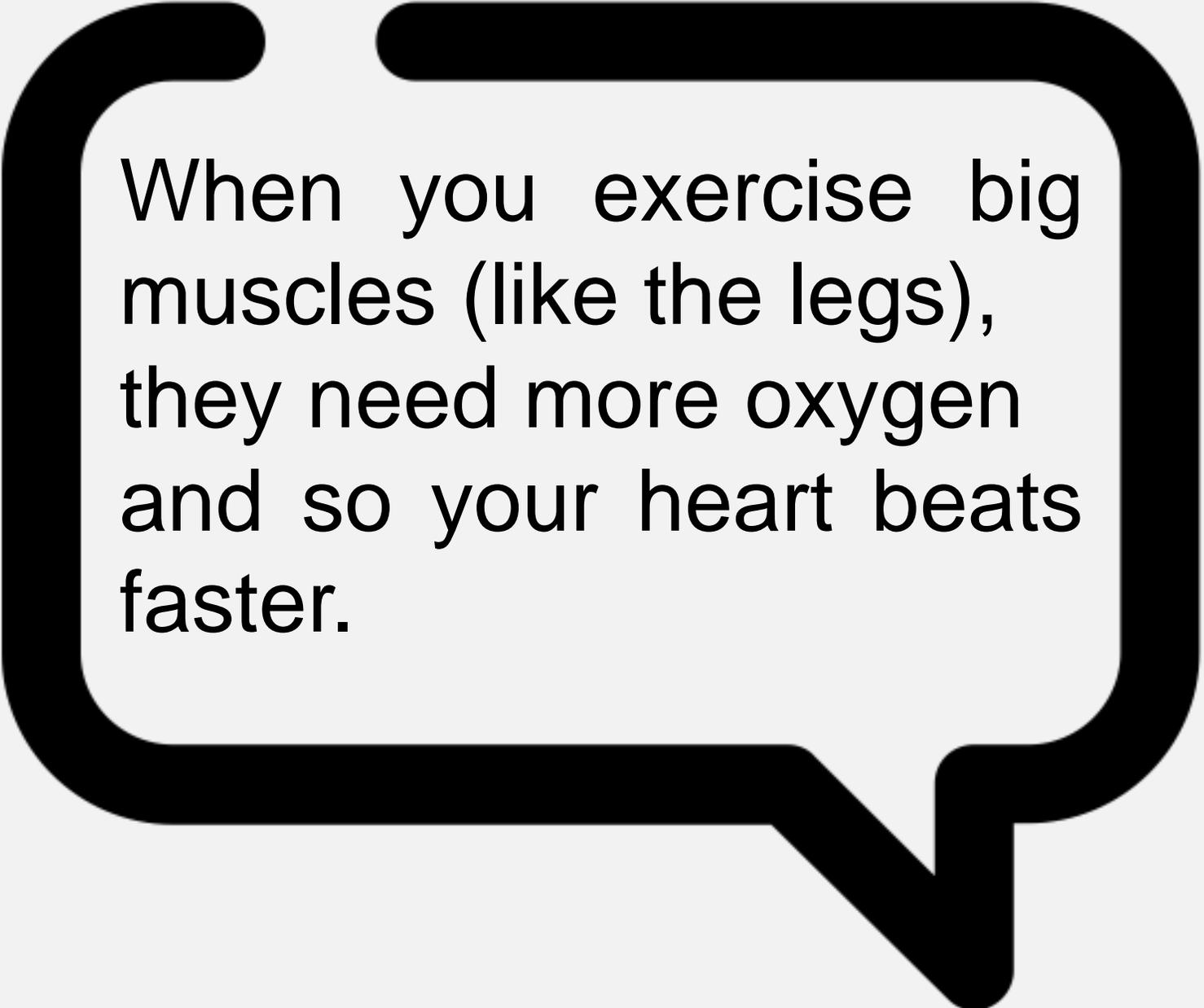
time

the

Visual Repository of Experiment Results

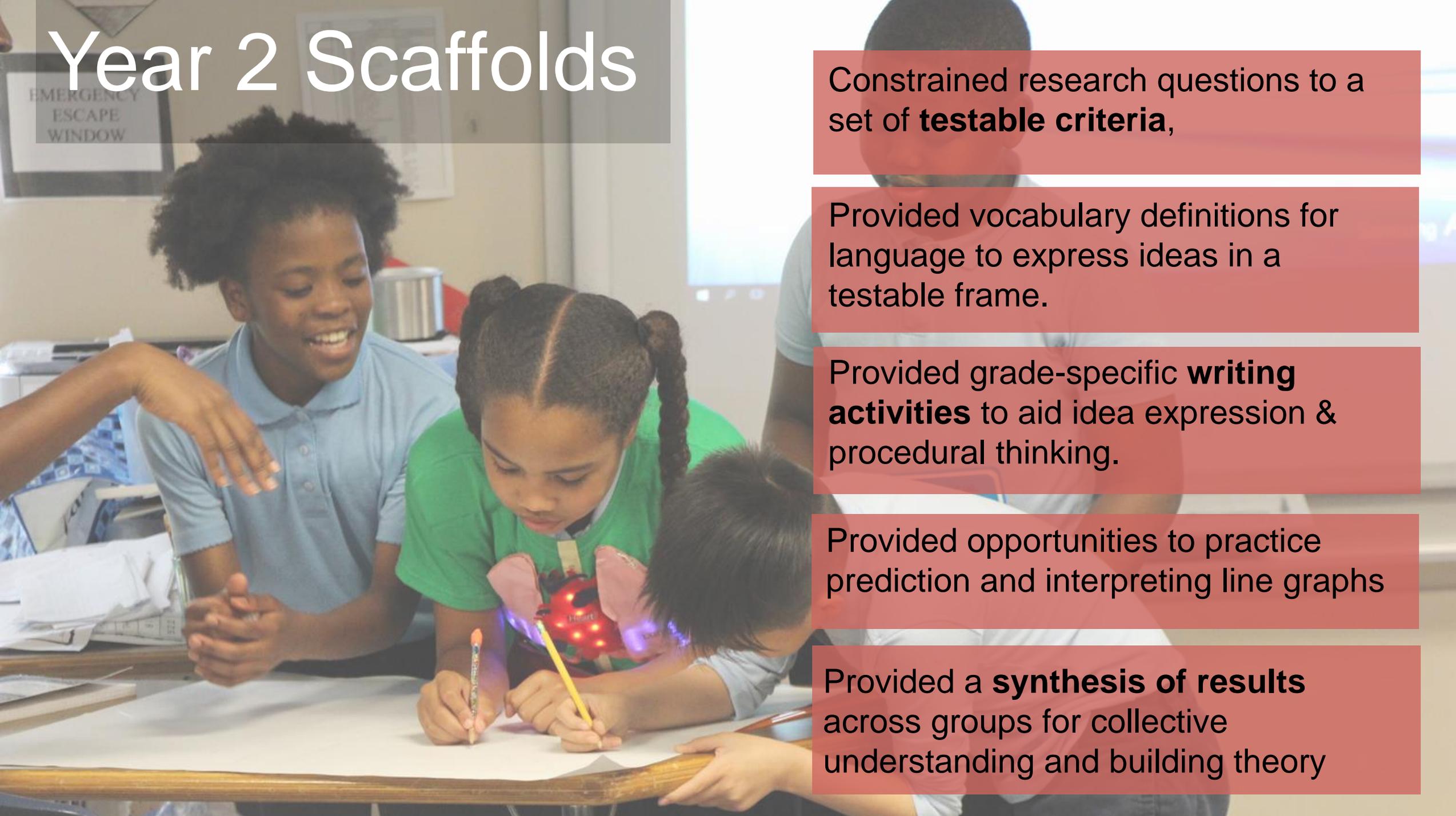
Physical Activity	Heart Rate Start → Finish
TAG	
RUNNING FAST MAX	125bpm → 160bpm
FROG JUMP	
SKI JUMP Caleb	140bpm → 150bpm
JUMPING JACKS	
PUSH UPS charc	120bpm → 150bpm

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	



When you exercise big muscles (like the legs), they need more oxygen and so your heart beats faster.

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



Future
Research

The BodyVis Team



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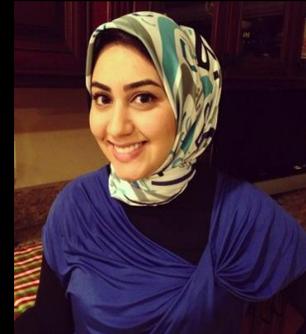
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