Scaffolding Wearable-Based Scientific Inquiry for Early Learners

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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
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
Moving Graphs

Kang et al., 2016
Leveraging the Body as a Platform for Inquiry

Enable kids to ask questions, collect & analyze data, & make claims

Embodied Learning Approach (Lee, 2015)
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

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.
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
Video Data & Photographs

Teacher Interviews

Facilitator Post Observation Field Notes

Inquiry Project Artifacts
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.
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

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. Breathe in, then hold your breath. Check the heart rate again. If the heart rate increases or decreases, check the heart rate again.
Visual Repository of Experiment Results

<table>
<thead>
<tr>
<th>Physical Activity</th>
<th>Heart Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>TAG</td>
<td></td>
</tr>
<tr>
<td>Running Fast</td>
<td>125 bpm → 160 bpm</td>
</tr>
<tr>
<td>Frog Jump</td>
<td></td>
</tr>
<tr>
<td>Ski Jump</td>
<td>140 bpm → 150 bpm</td>
</tr>
<tr>
<td>Push Ups</td>
<td>120 bpm → 150 bpm</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Physical Activity</th>
<th>Heart Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Galloping vs. Chill</td>
<td></td>
</tr>
<tr>
<td>Doing Homework</td>
<td></td>
</tr>
<tr>
<td>Jumping high</td>
<td>Increased</td>
</tr>
<tr>
<td>Running vs. Jumping</td>
<td>Running increased less than jumping</td>
</tr>
<tr>
<td>Dancing</td>
<td></td>
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</tbody>
</table>

Test

<table>
<thead>
<tr>
<th>Conclusion</th>
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</thead>
<tbody>
<tr>
<td>Galloping increases heart rate</td>
</tr>
<tr>
<td>Chill makes heart rate stay the same</td>
</tr>
<tr>
<td>Homework makes heart rate stay the same</td>
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When you exercise big muscles (like the legs), they need more oxygen and so your heart beats faster.
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