SharedPhys

Live Physiological Sensing, Whole-Body Interaction, & Large-Screen Vis to Support Shared Inquiry Experiences

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UNIVERSITY OF MARYLAND COMPUTER SCIENCE UNIVERSITY OF MARYLAND makeability lab HCIL

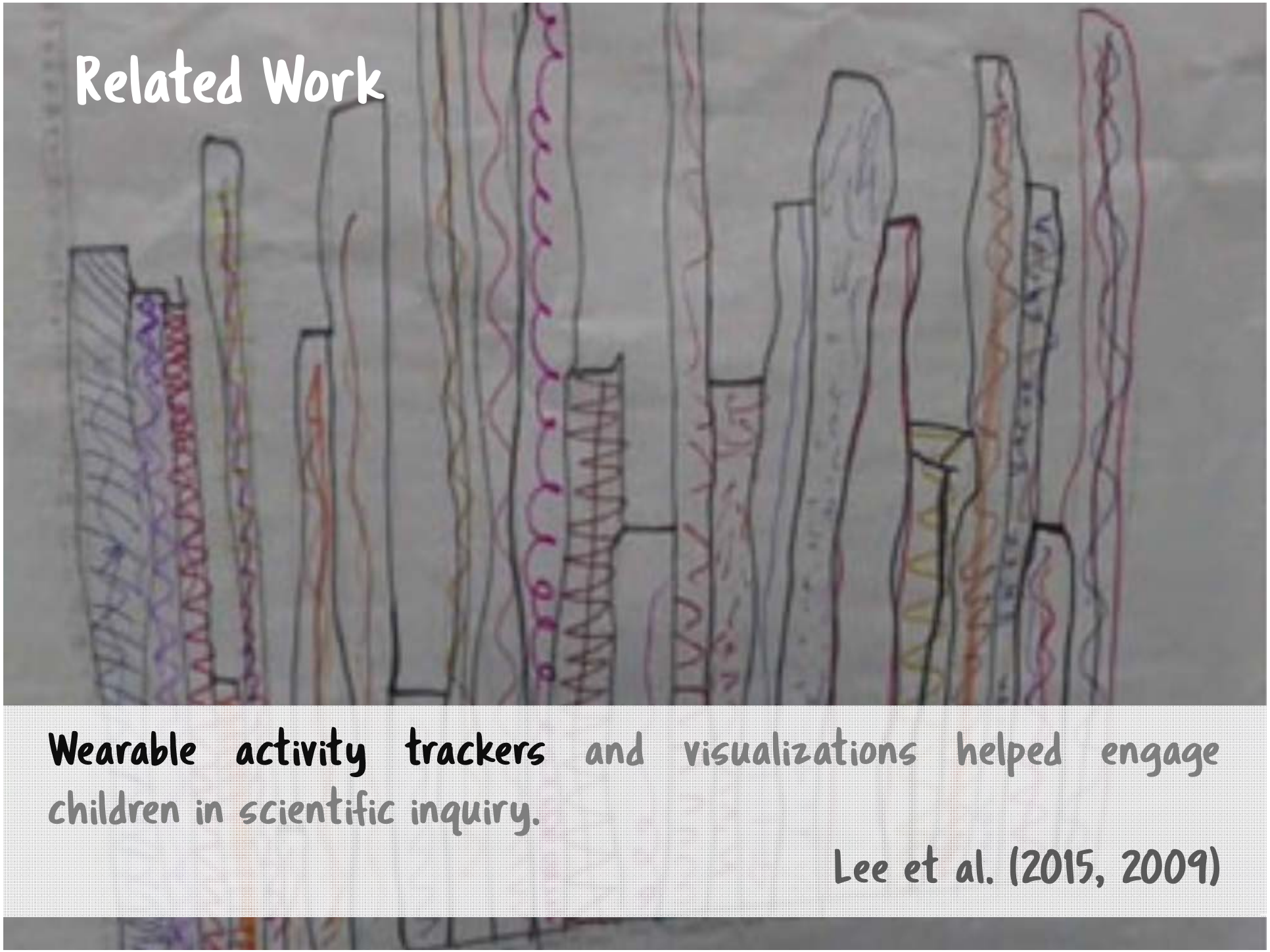
Our vision is to create a learning platform where children can use their body to build scientific inquiry skills

Related Work

Wearable activity trackers and visualizations helped engage children in scientific inquiry.

Lee et al. (2015, 2009)

Related Work



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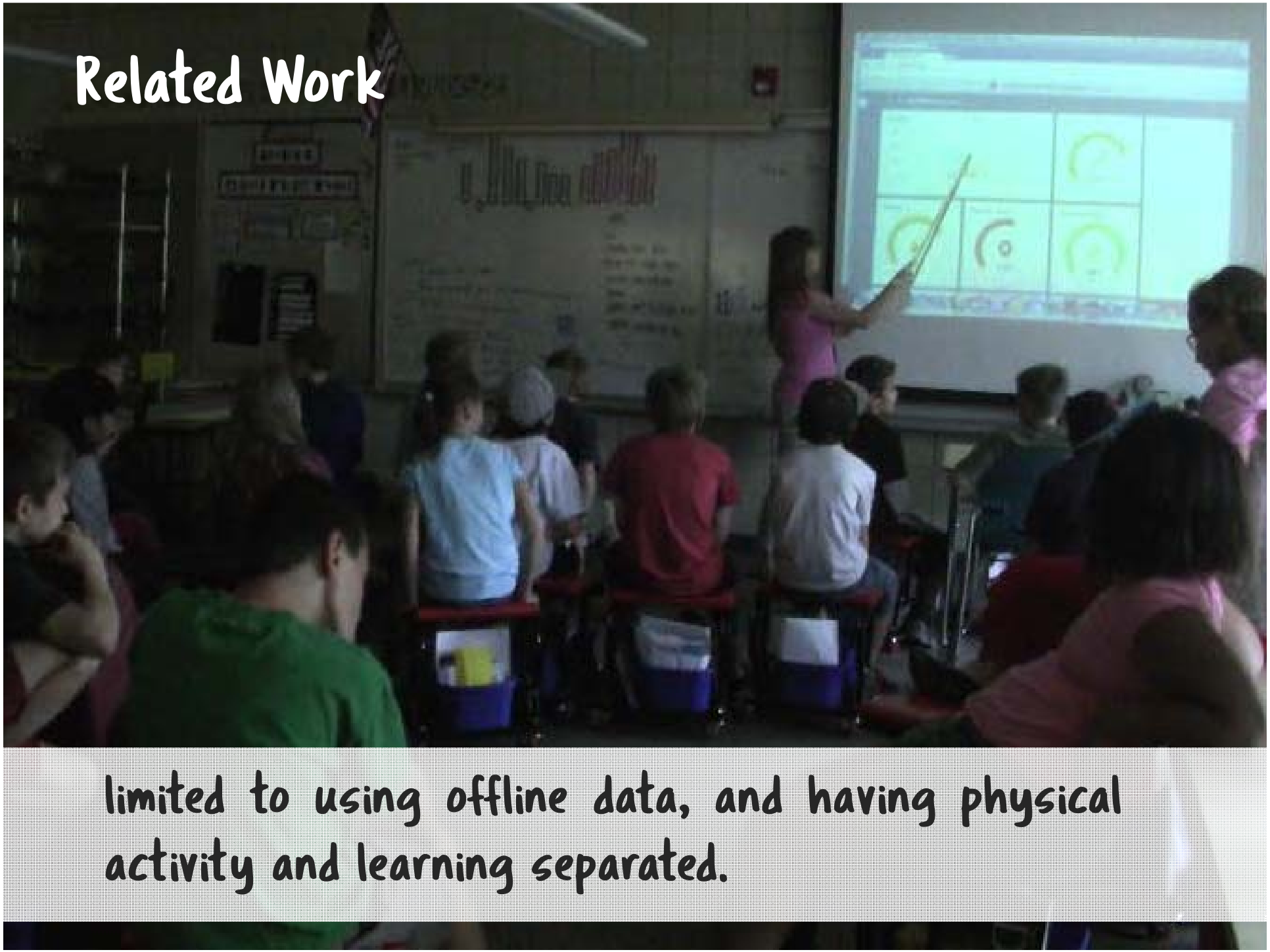
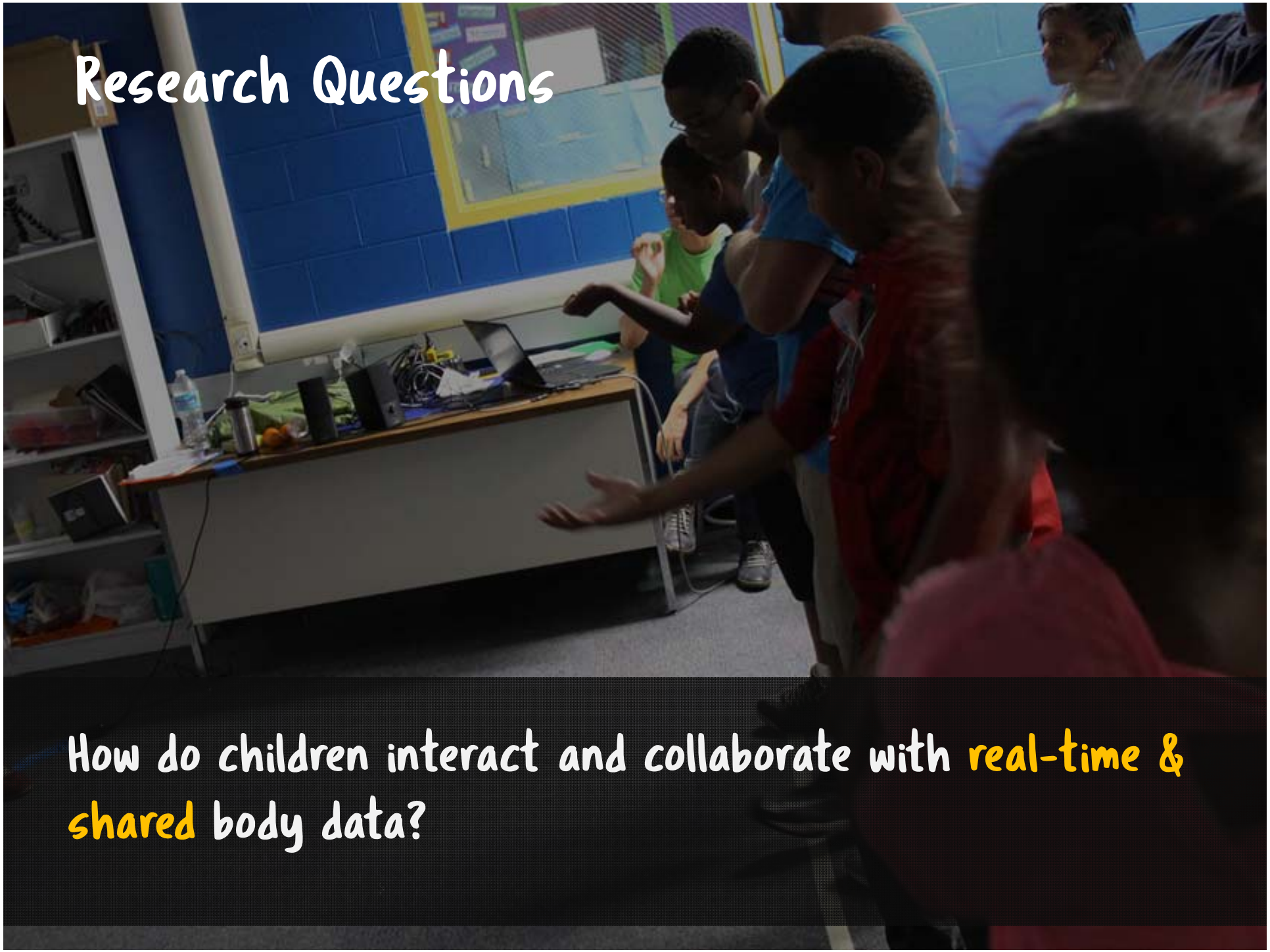
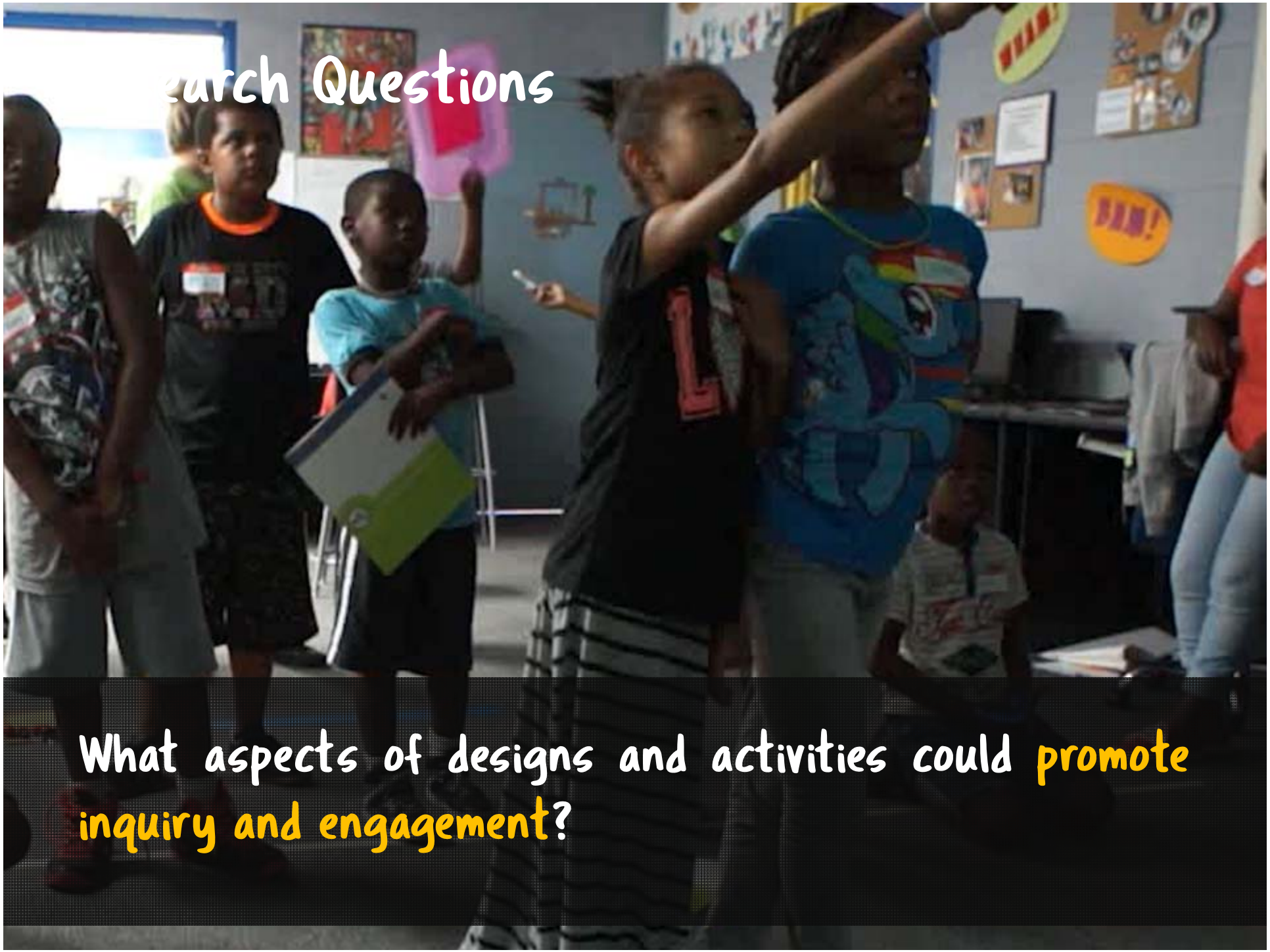


limited to using offline data, and having physical activity and learning separated.

Research Questions

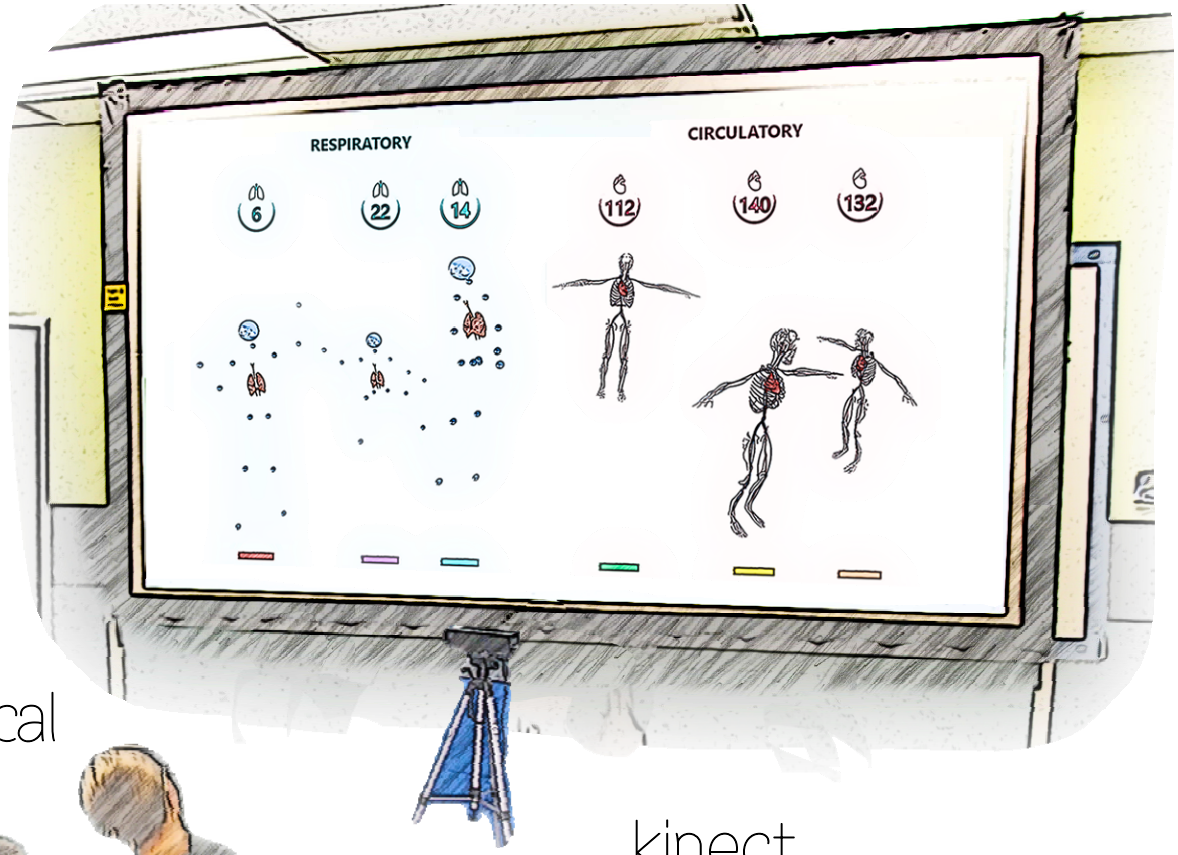


How do children interact and collaborate with real-time & shared body data?

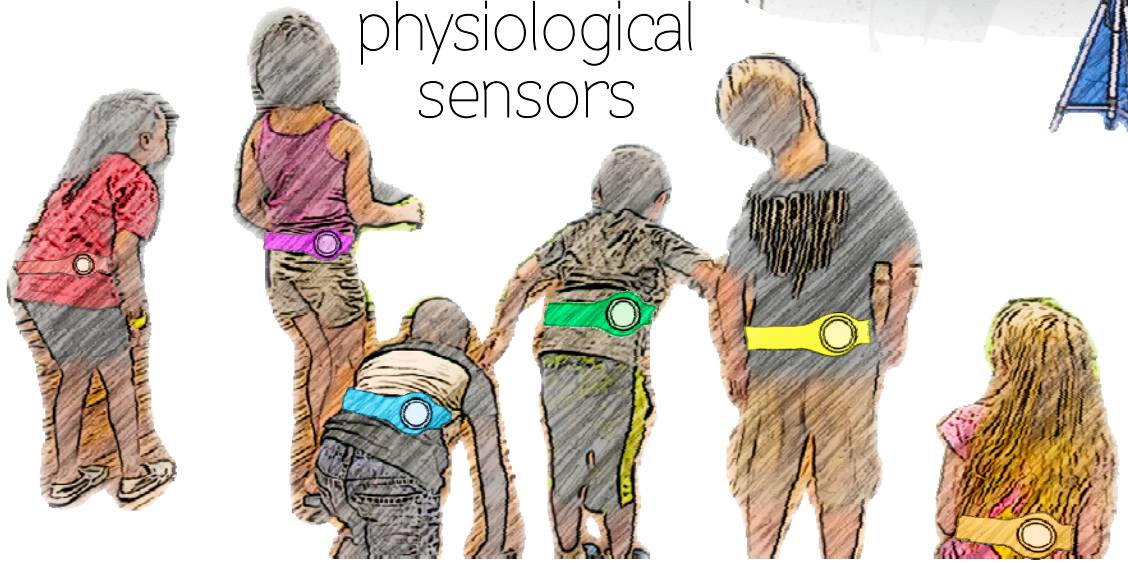

earch Questions
What aspects of designs and activities could promote inquiry and engagement?

SharedPhys, Mixed-Reality Learning Environment

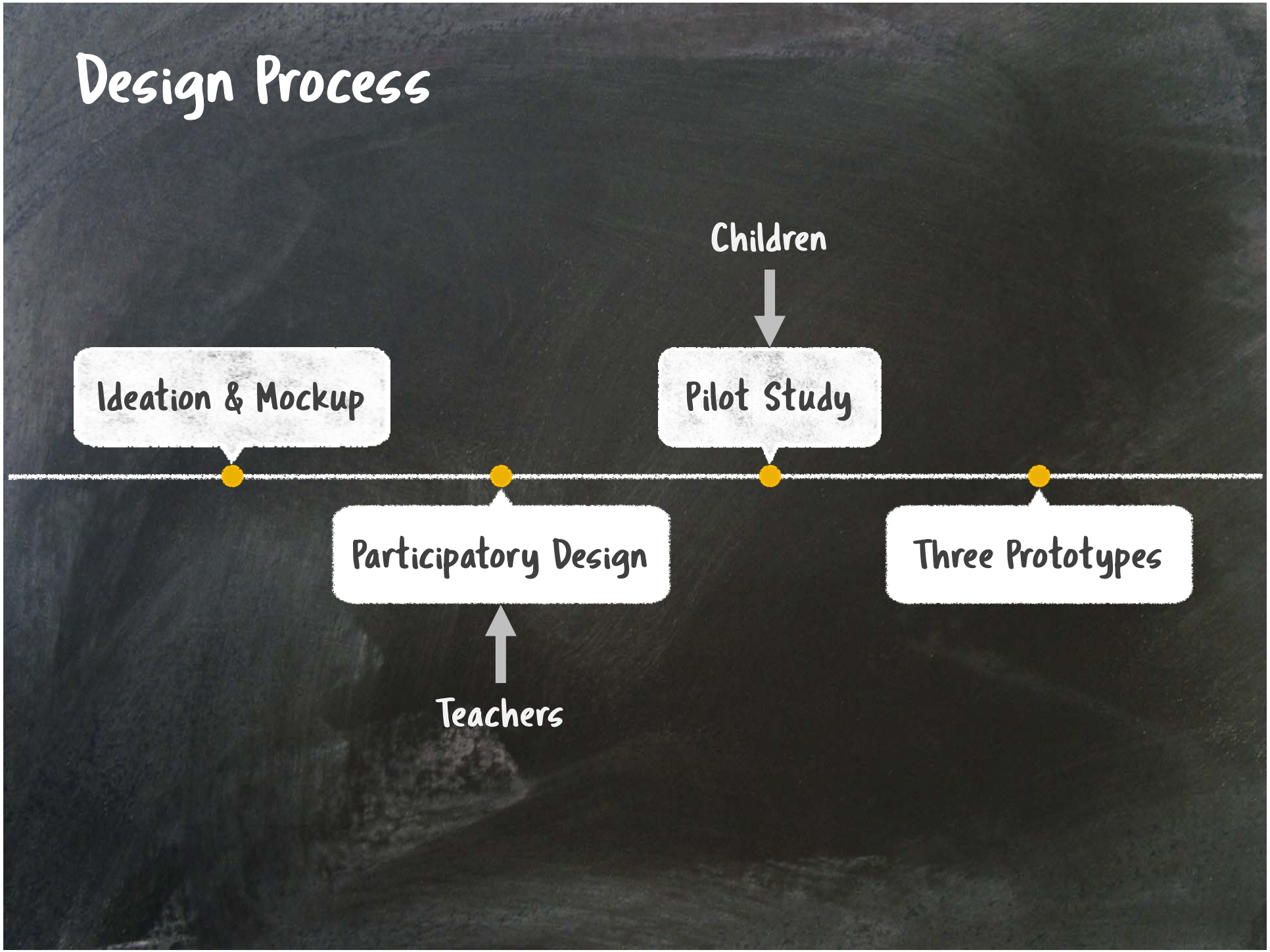
large
display

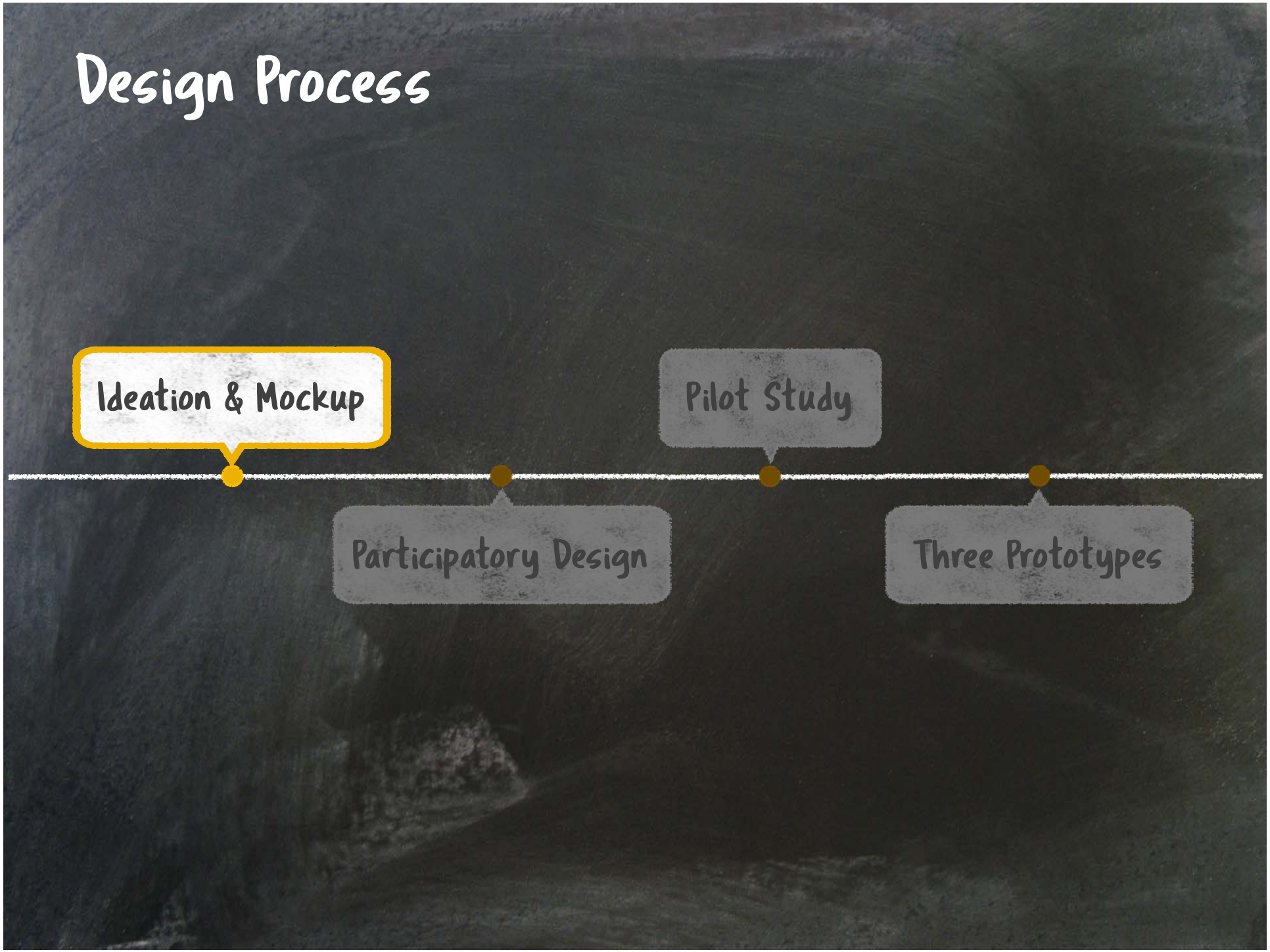


physiological
sensors



kinect
camera


Design Process
Children
Ideation & Mockup
Pilot Study
Participatory Design
Three Prototypes
Teachers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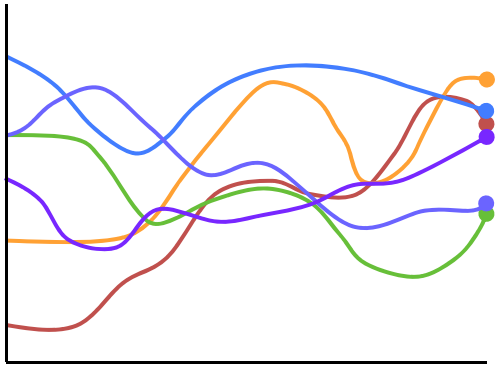
Three Prototypes

Heart Rate

Bob	Lily	Adam	Tim	Jill
141	134	130	100	95
Joe	Mike	Lisa	Chelsea	Sarah
130	134	141	95	100
Bob	Lily	Adam	Tim	Jill
141	134	130	100	95
Bob	Lily	Adam	Tim	Jill
141	134	130	100	95
Bob	Lily	Adam	Tim	Jill
141	134	130	100	95

Group Averages



Highest

Bob: 141

Lowest

Jill: 95

Average

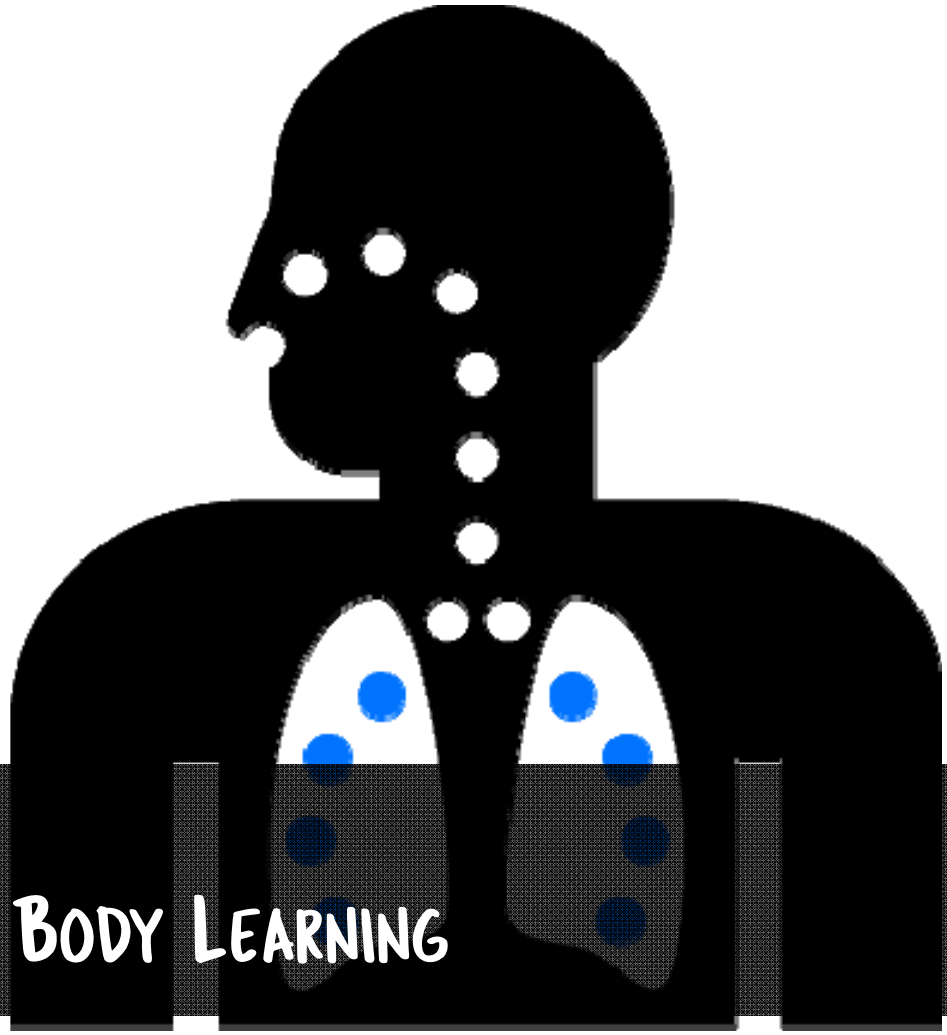
XXX

Mockup Example 1

Social Comparison of Live Body Data

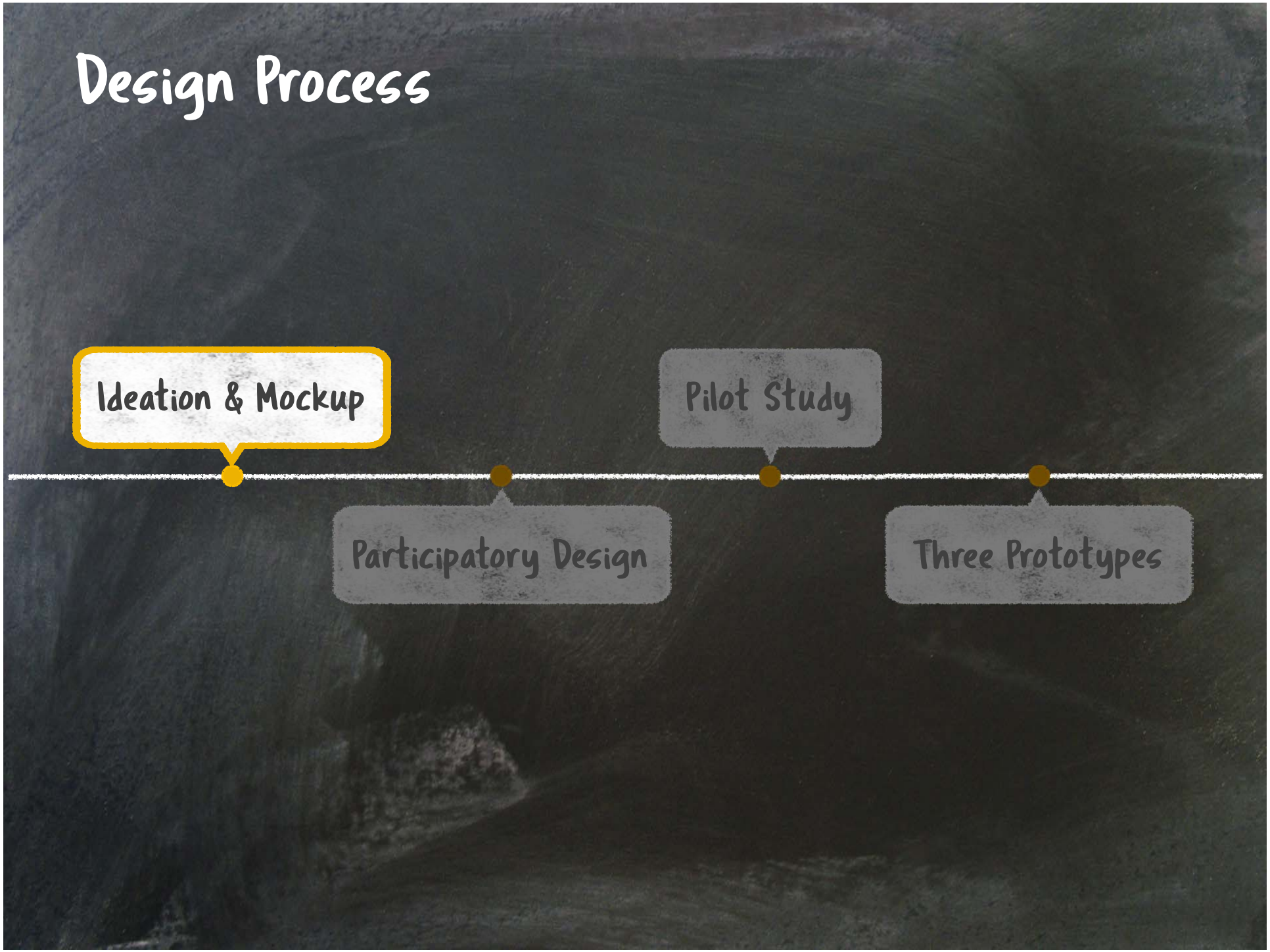
Breathing Rate

Adam	Jack	Jill	Lily	Tim	Vicky
17	11	19	15	12	20



Mockup Example 2

Connect With Body Learning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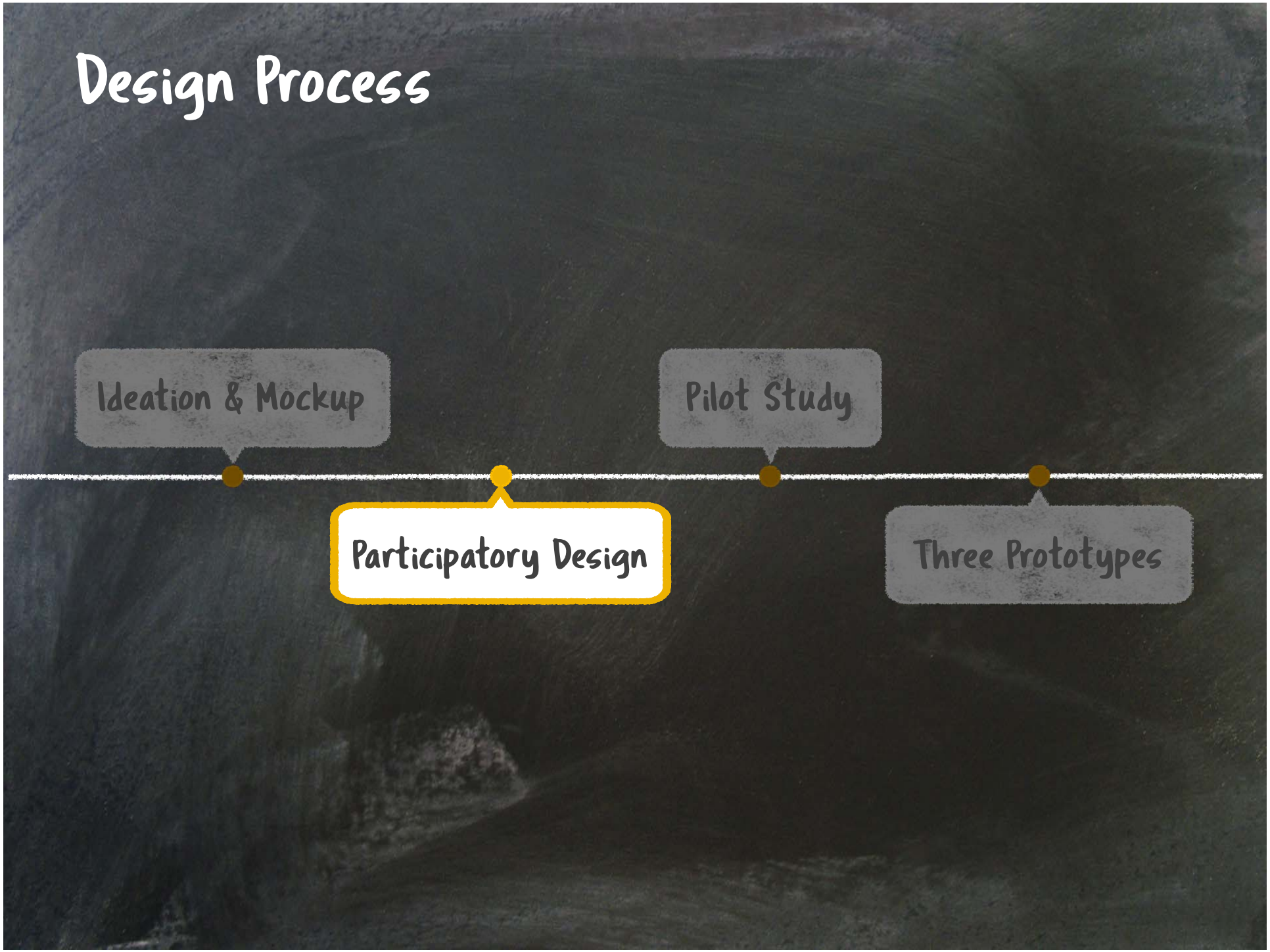
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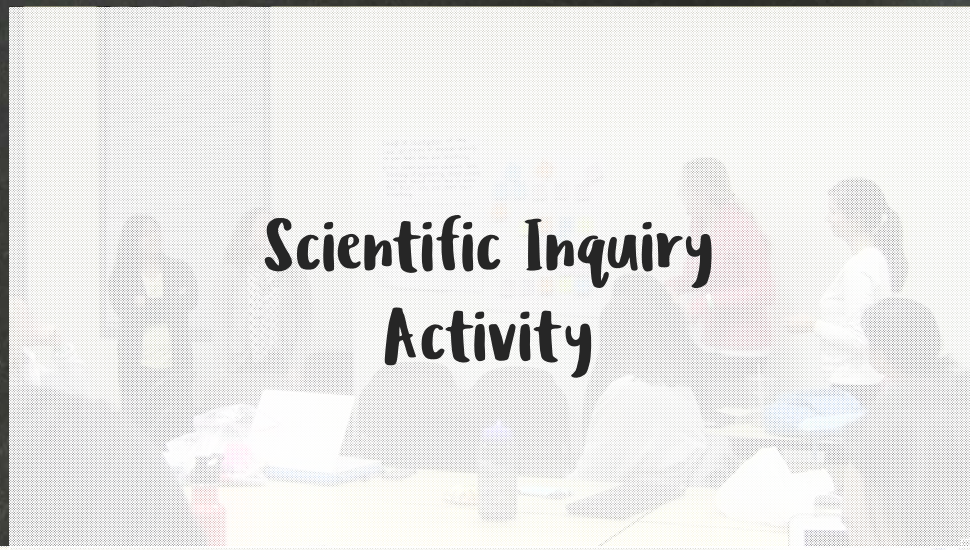
Design Process

Participatory Design

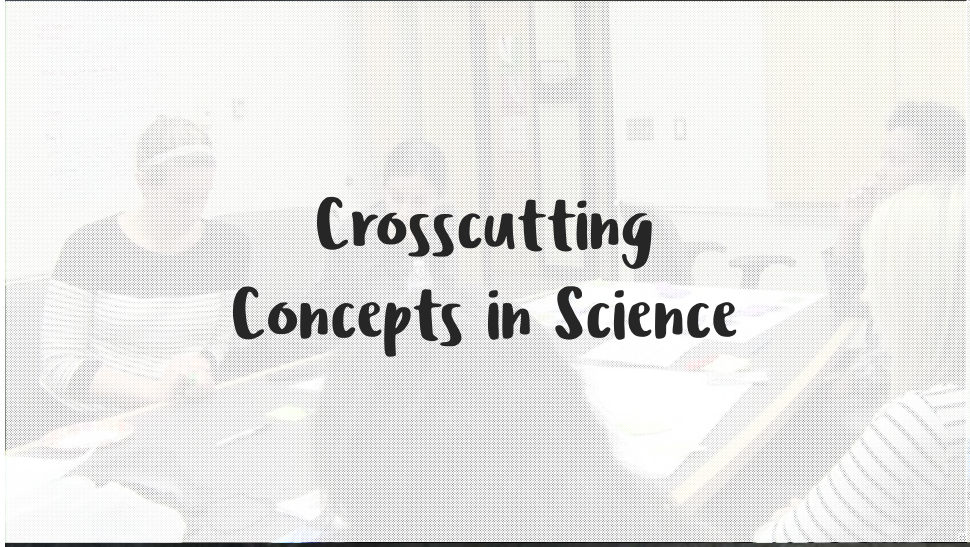
A formative design activity with experienced teachers to develop practical learning experiences

20 elementary school teachers

3 separate sessions, 2.5 hours

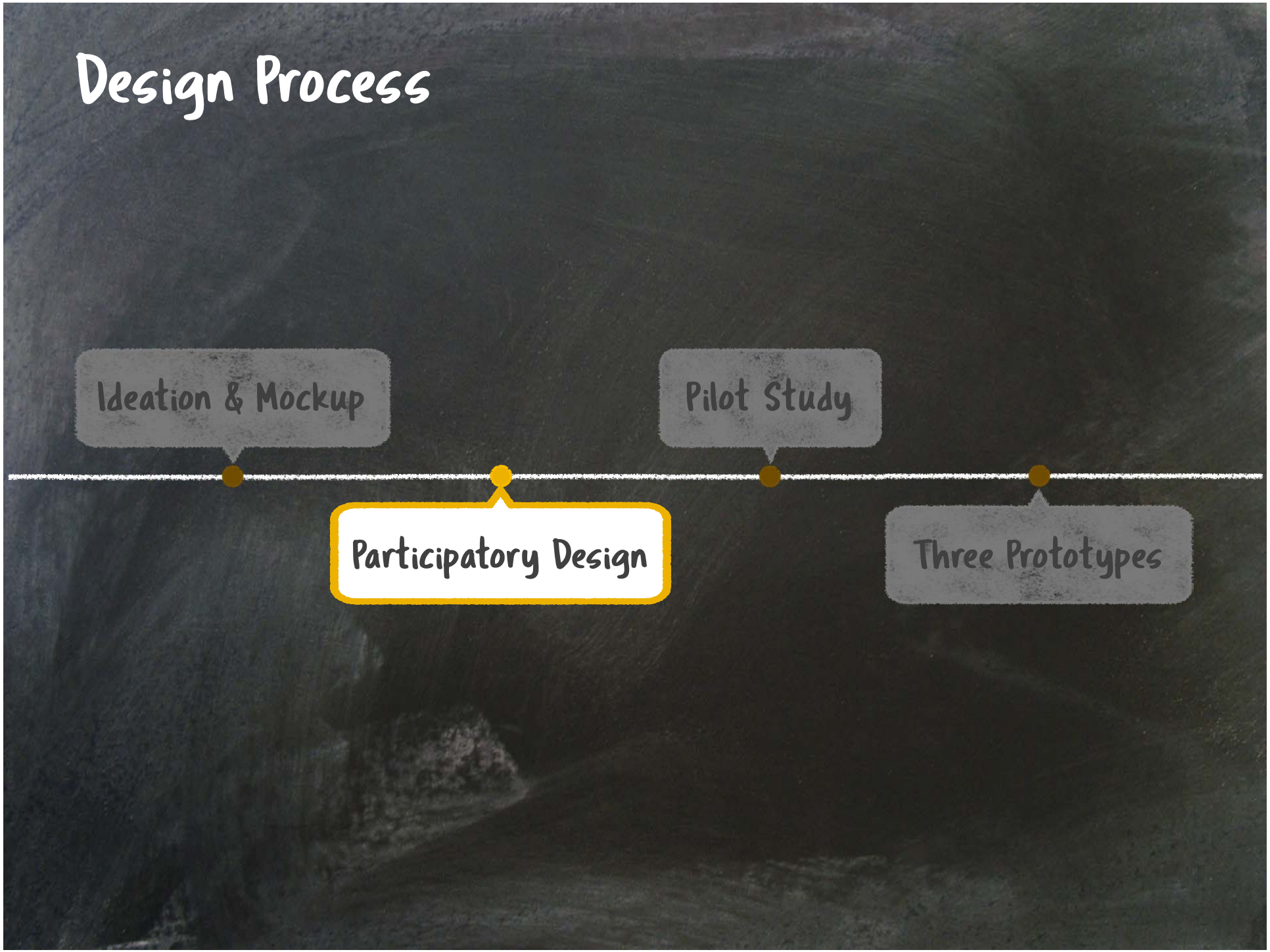


Scientific Inquiry Activity



Crosscutting Concepts in Science

The Form and Function of Human Body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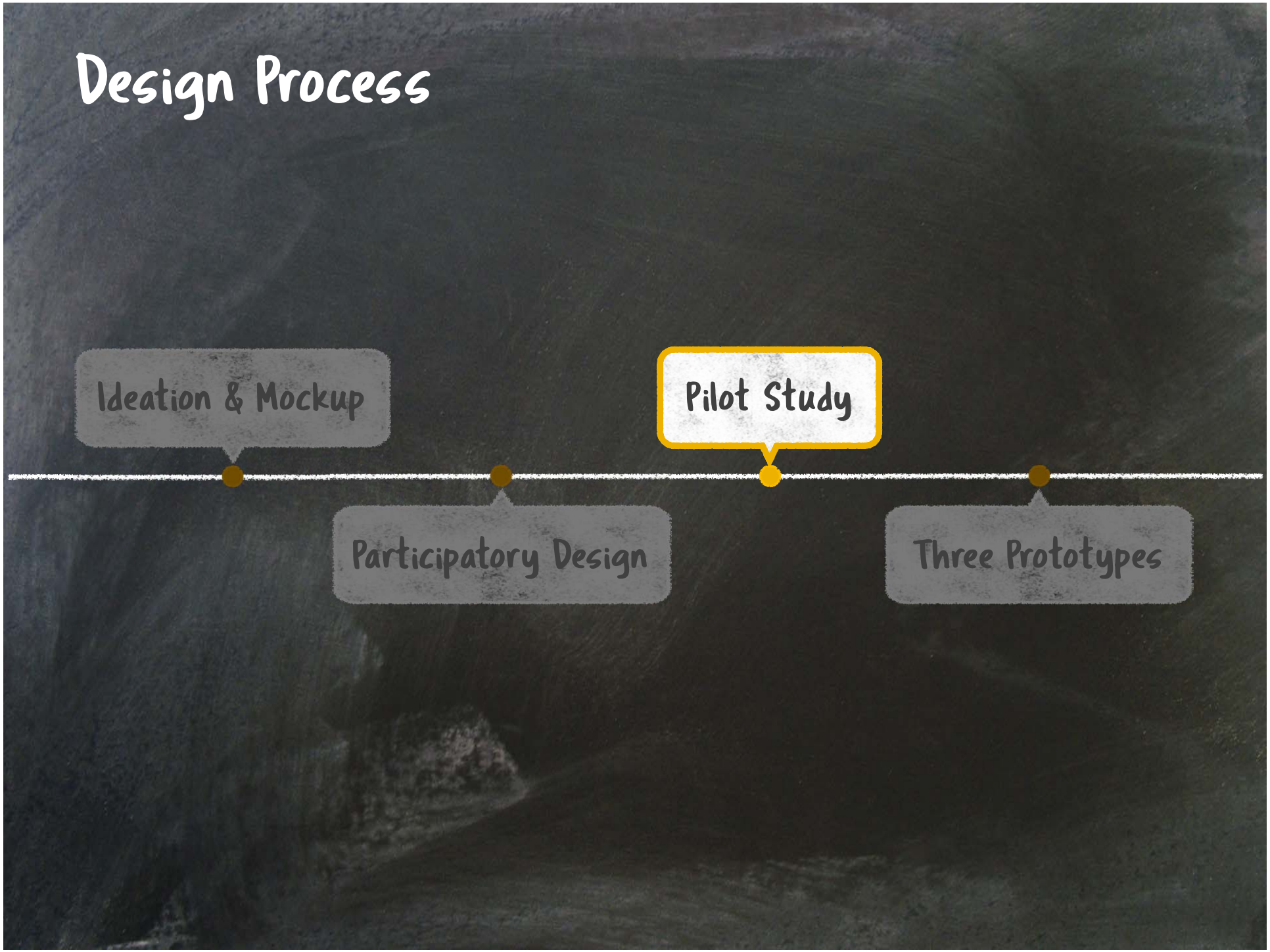
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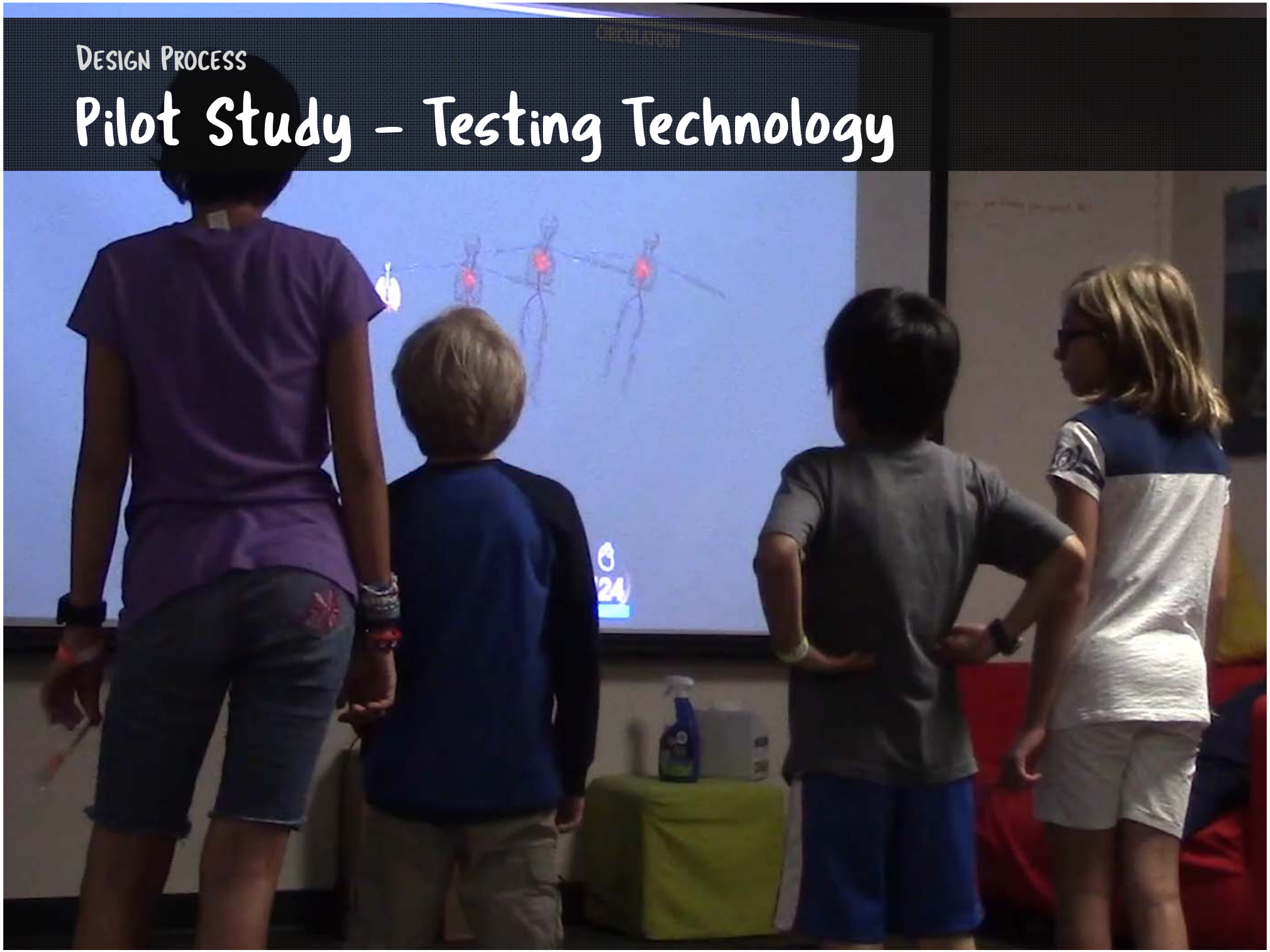
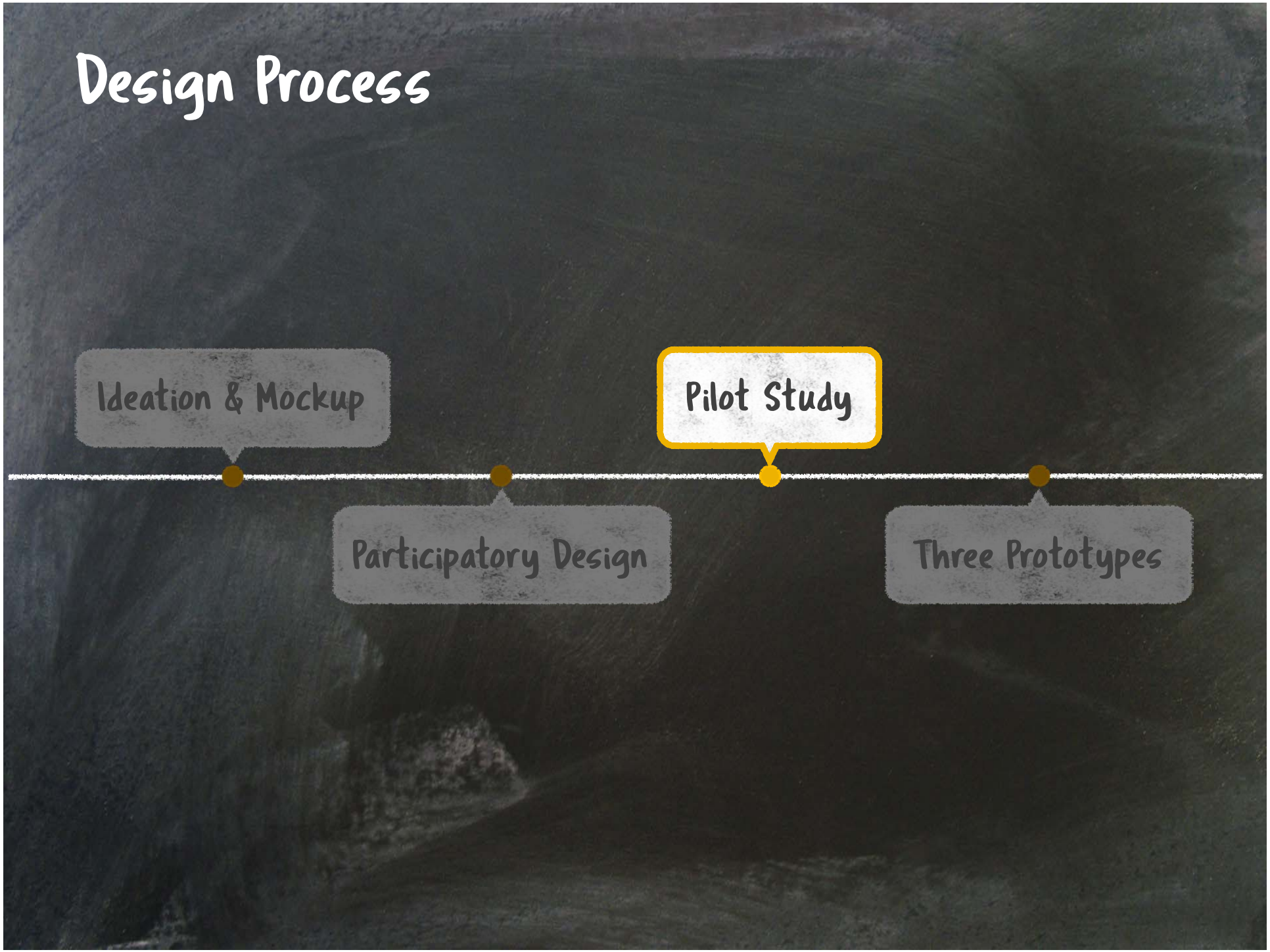
Design Process

Pilot Study – Testing Technology



Design Process

Pilot Study – Developing Learning Activities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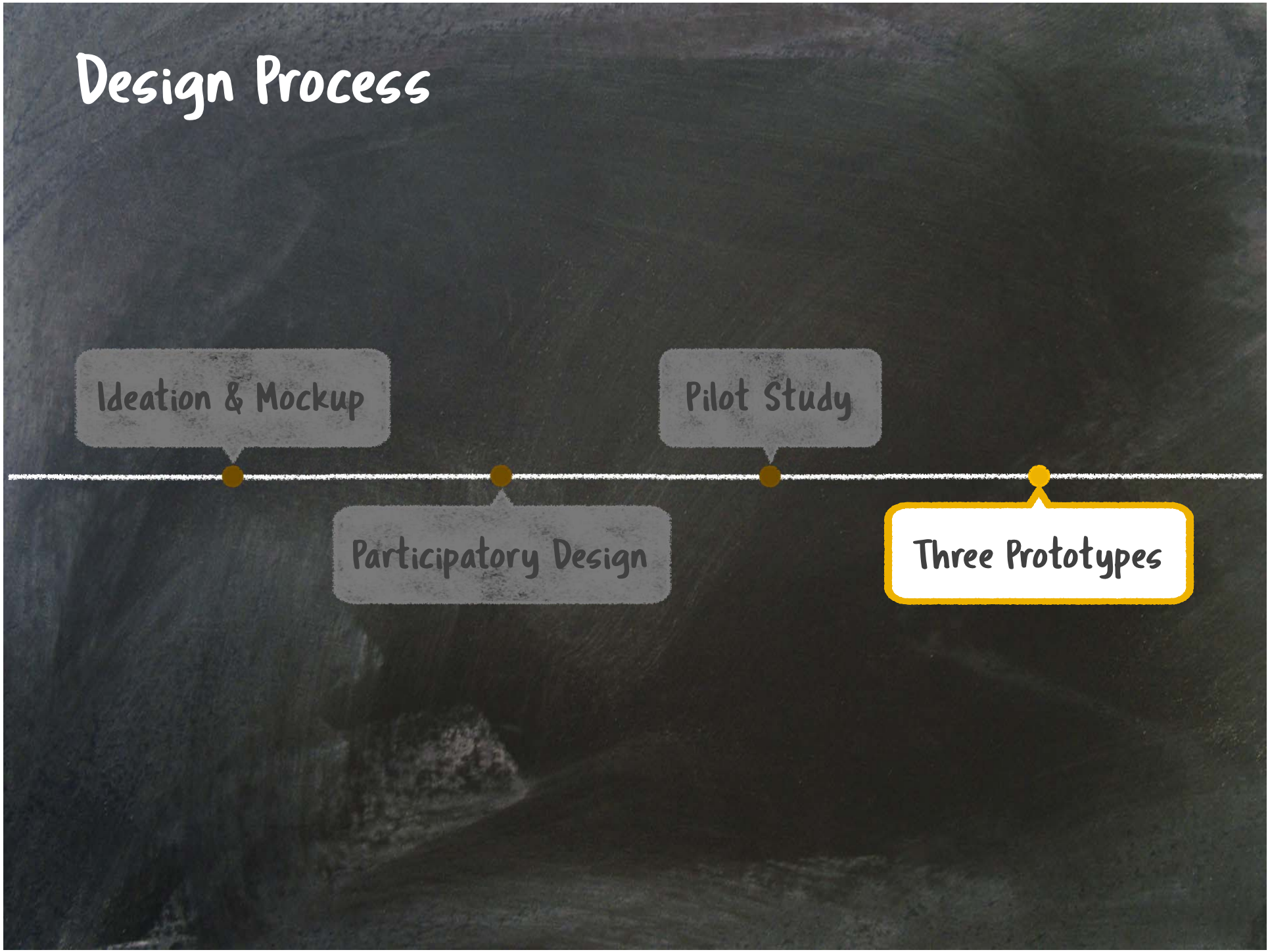
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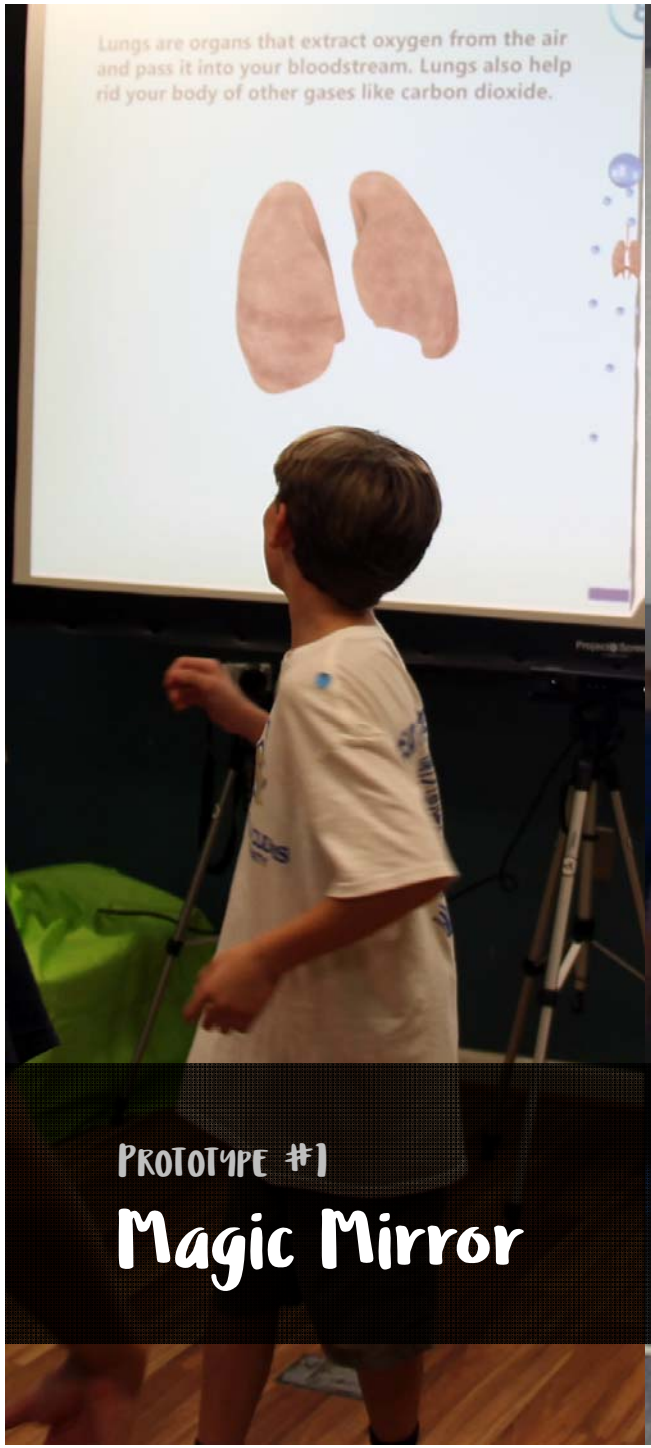


Prototype #1

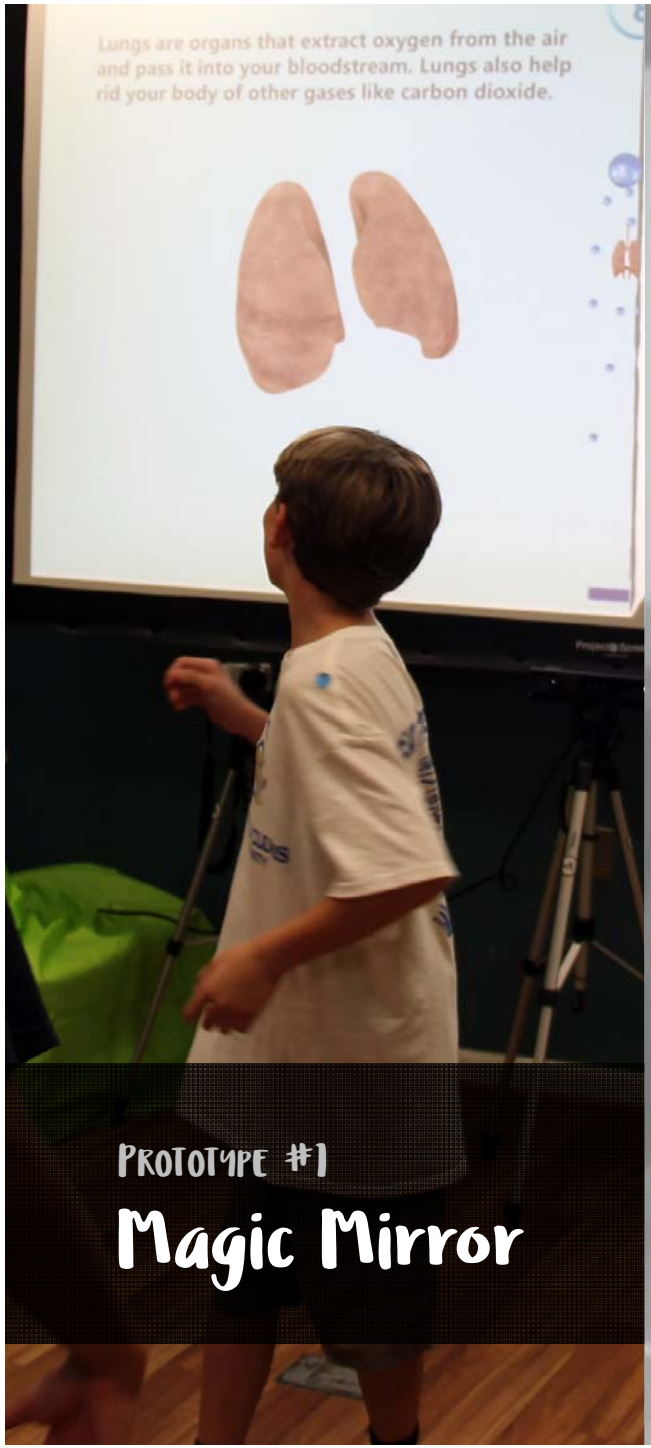
Magic Mirror

Prototype #2

Moving Graphs

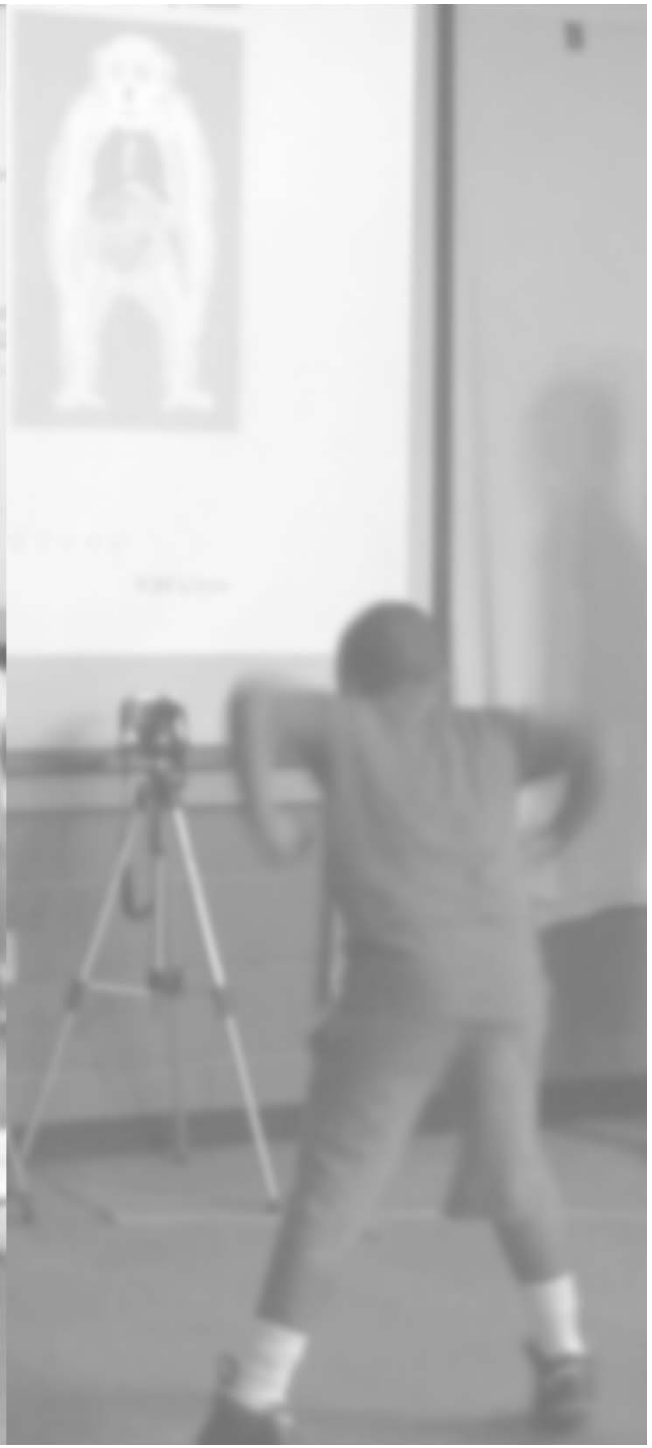
Prototype #3

Animal Avatar



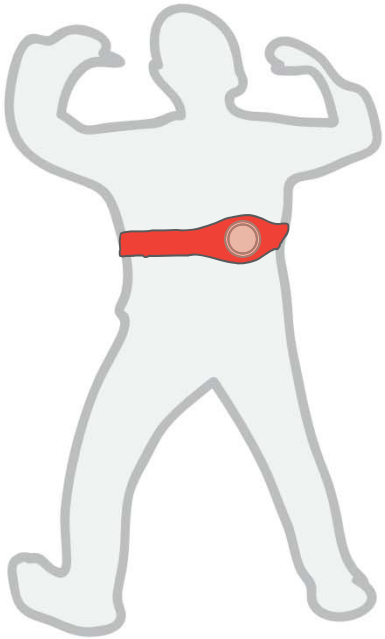
Prototype #1

Magic Mirror



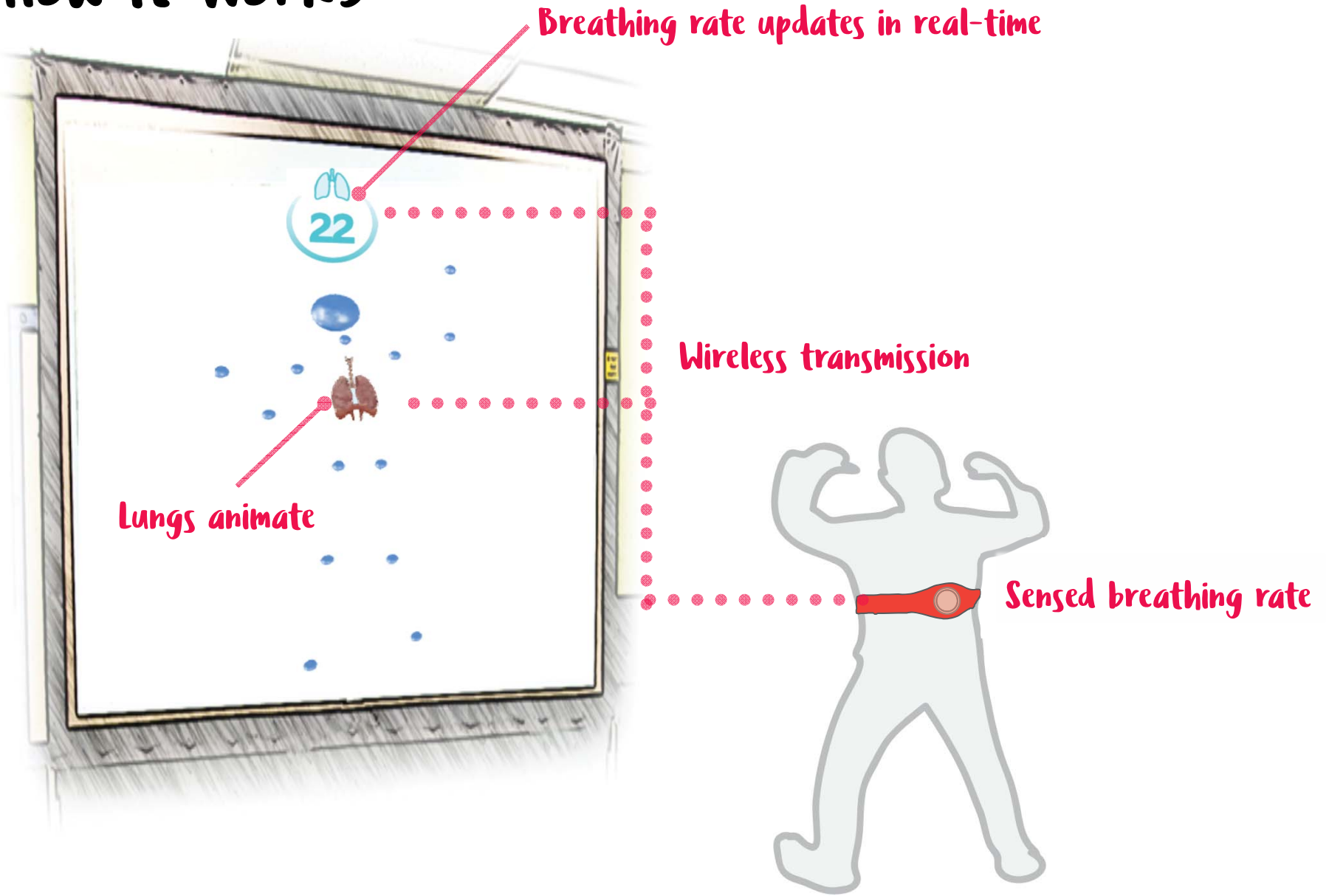
Design Goals

- Mirror paradigm
- Peer inside live body
- Whole-body interaction



Prototype #1: Magic Mirror

How It Works



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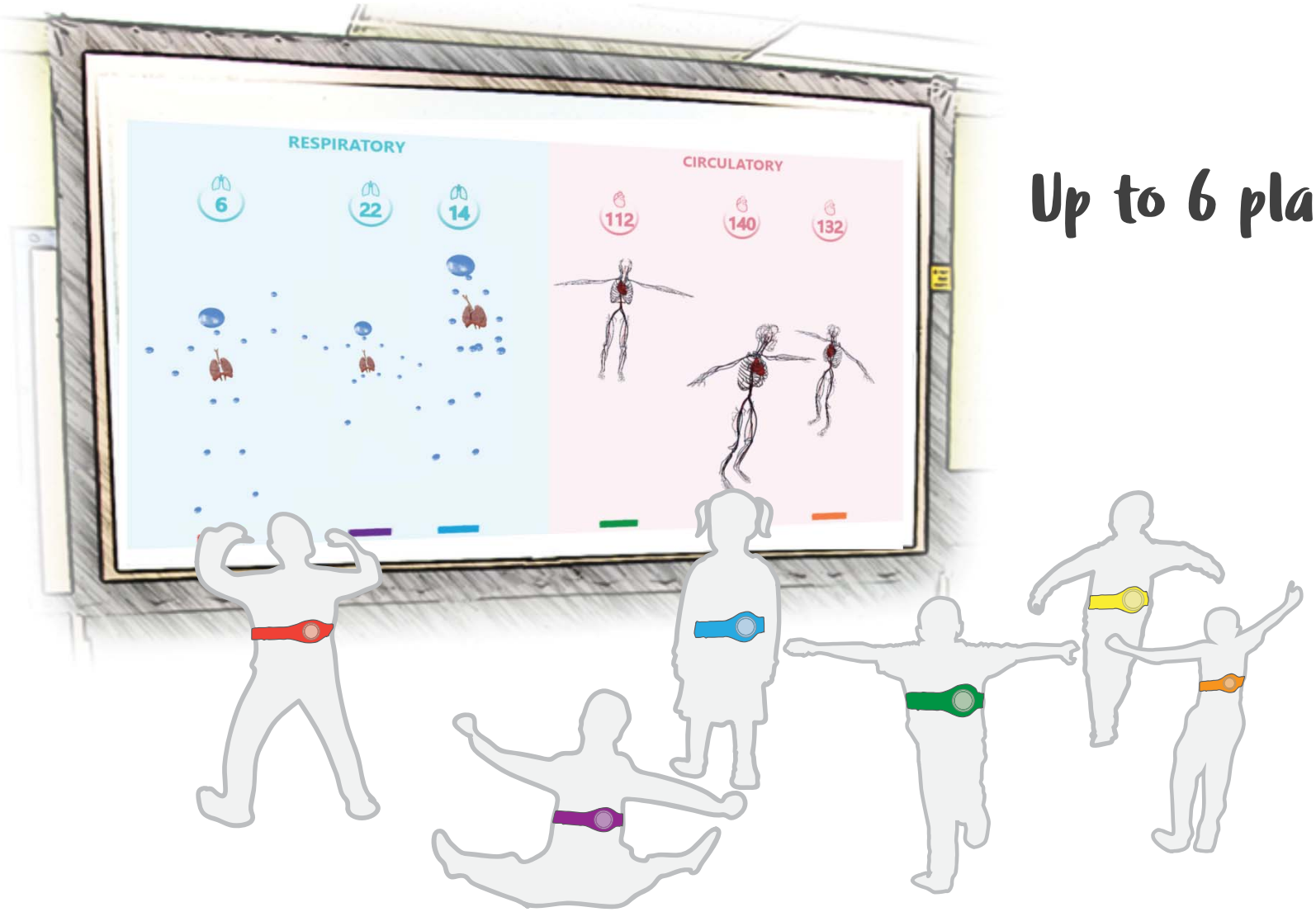
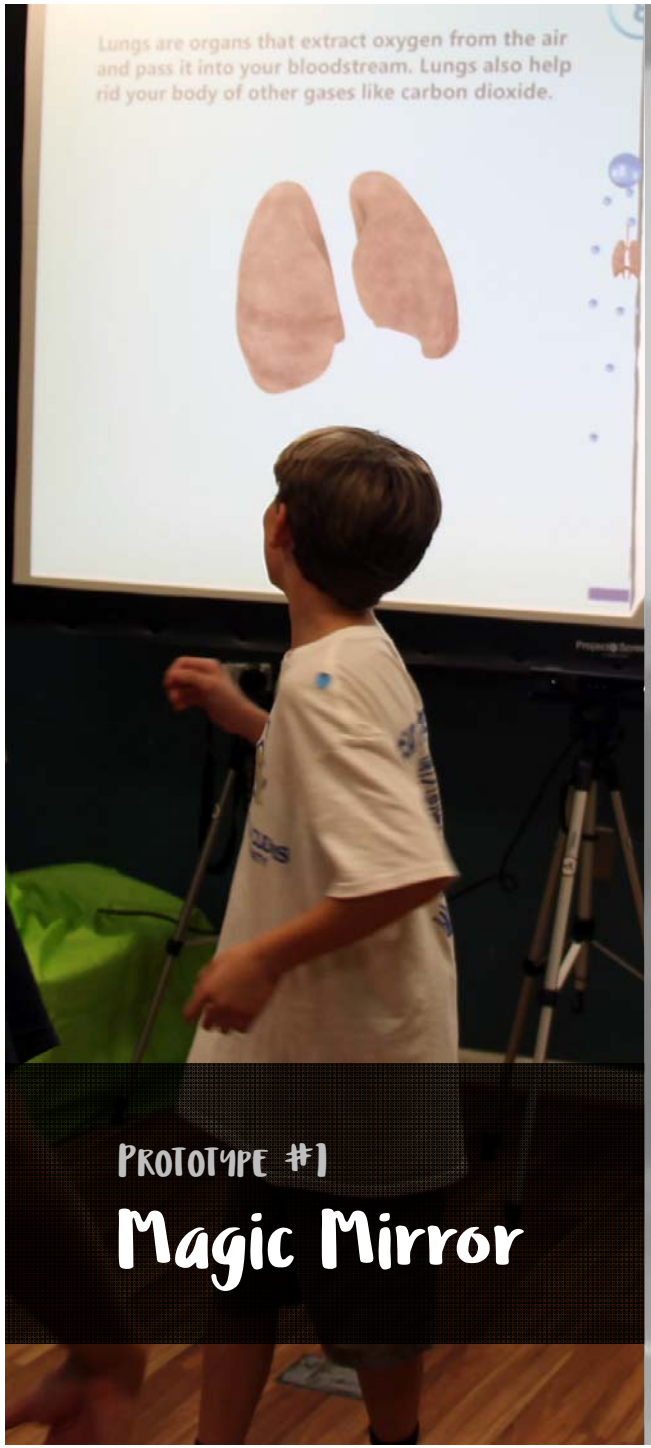


Up to 6 players



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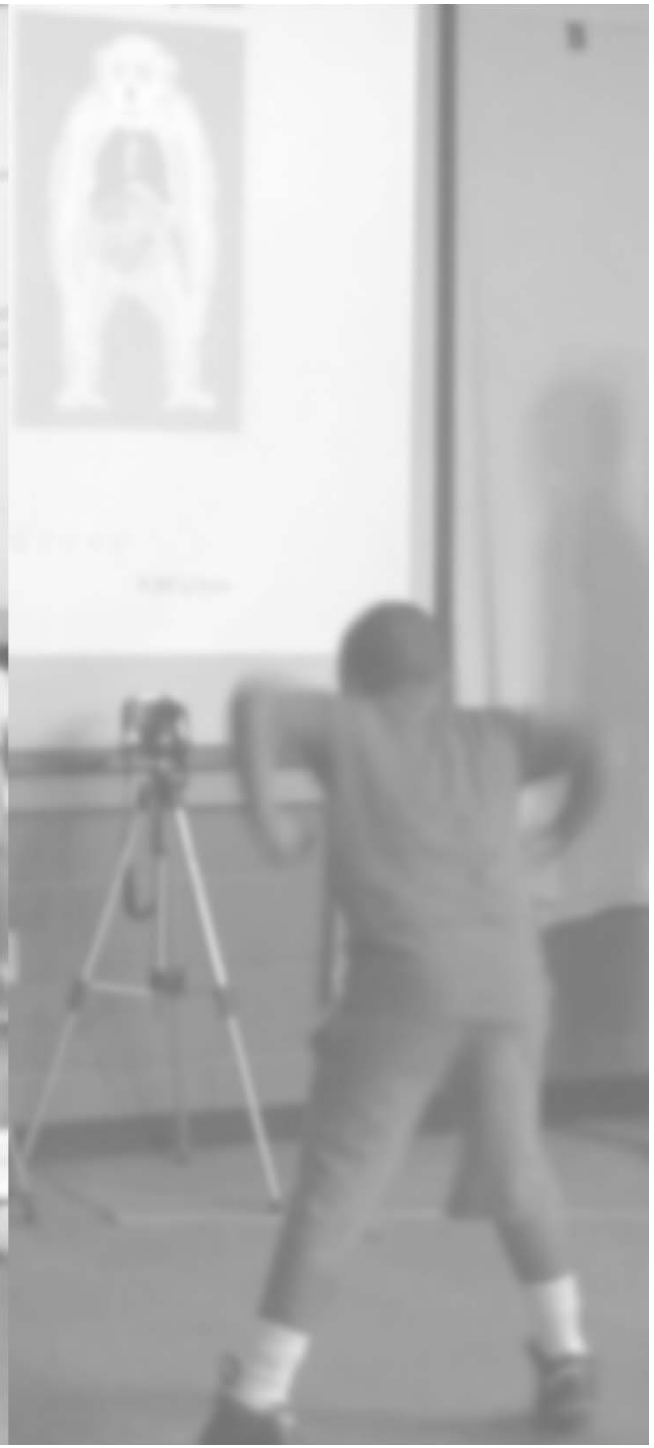
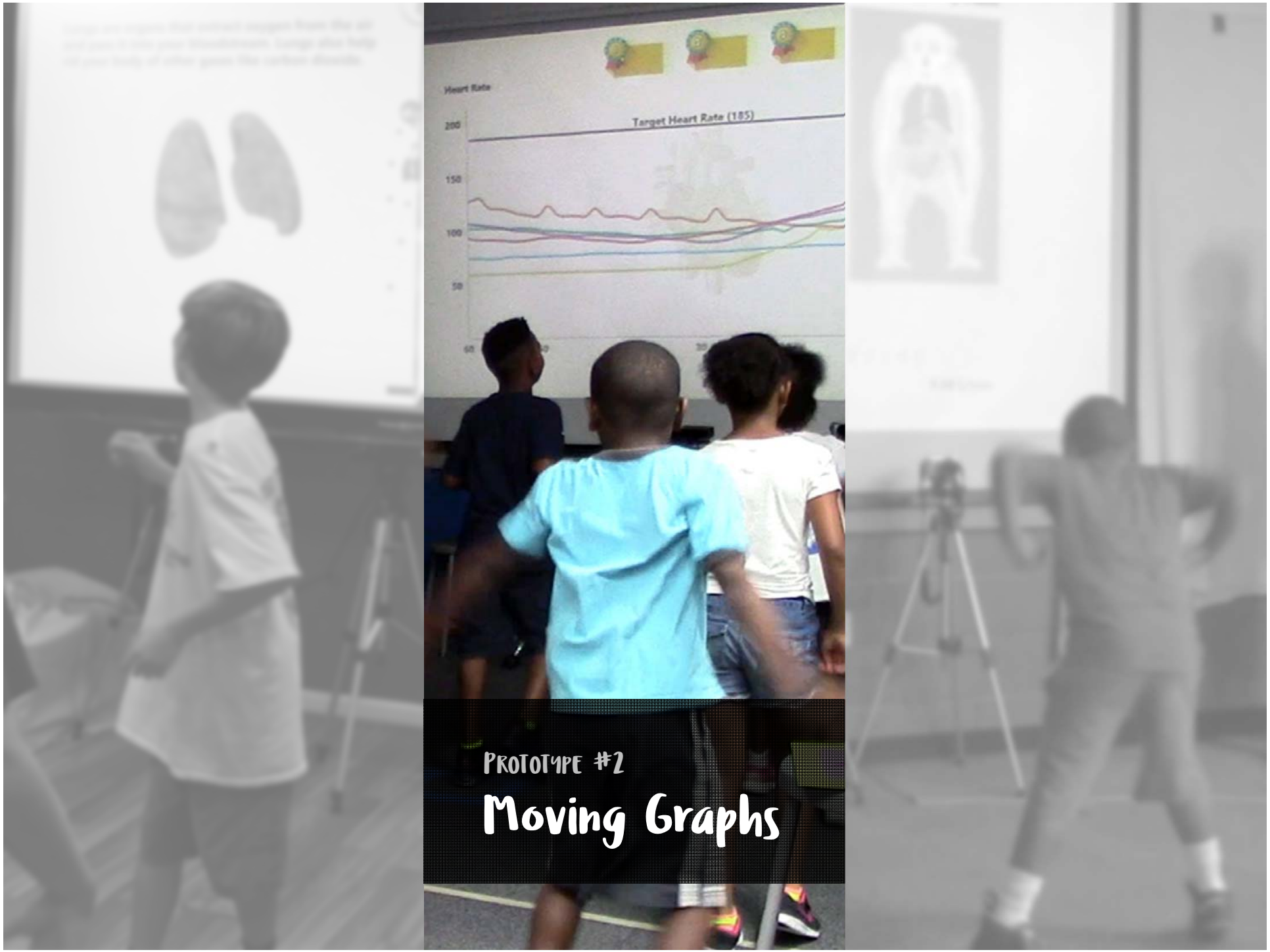
Magic Mirror



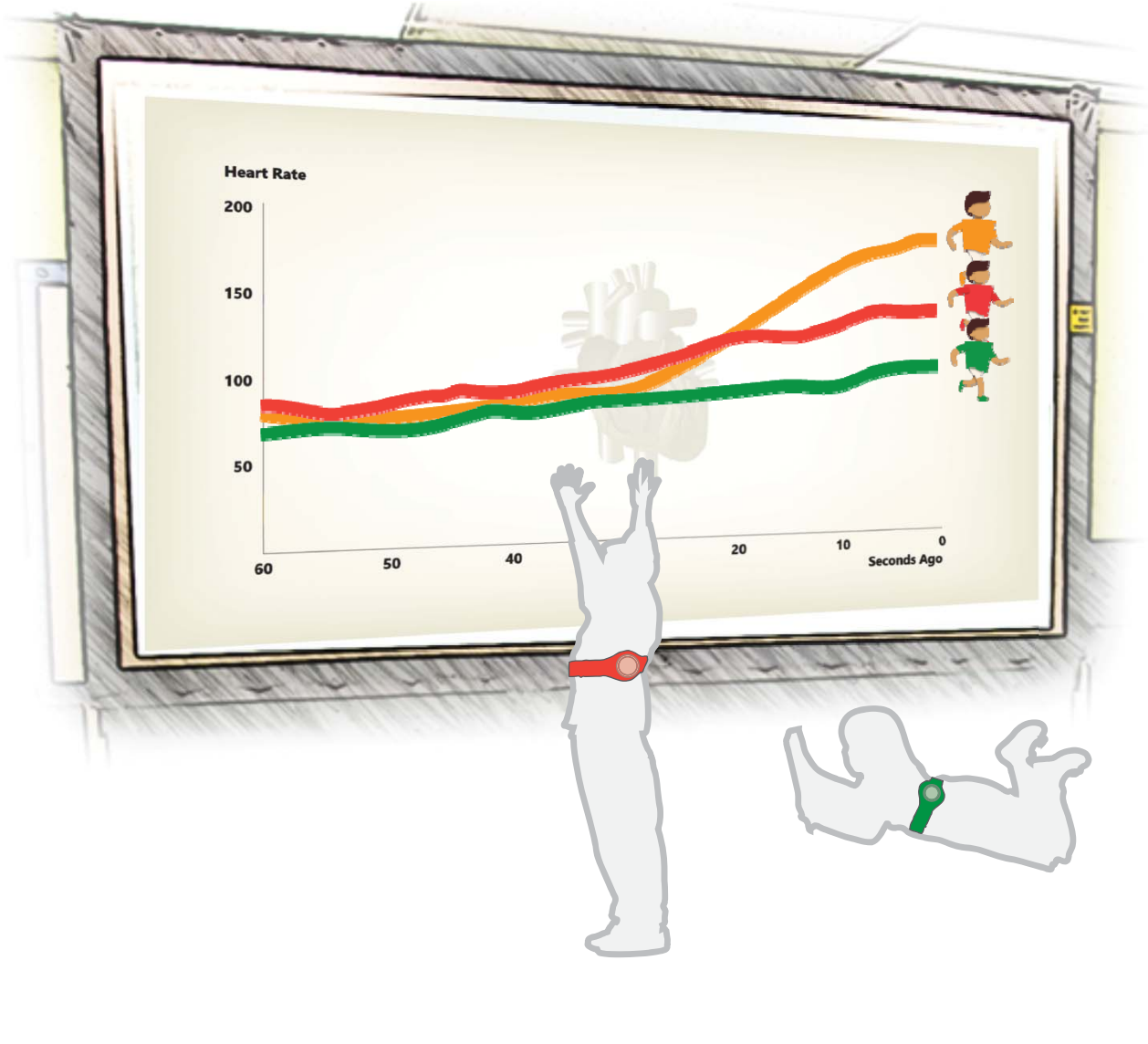


PROTOTYPE #2

Moving Graphs

Prototype #2: Moving Graphs

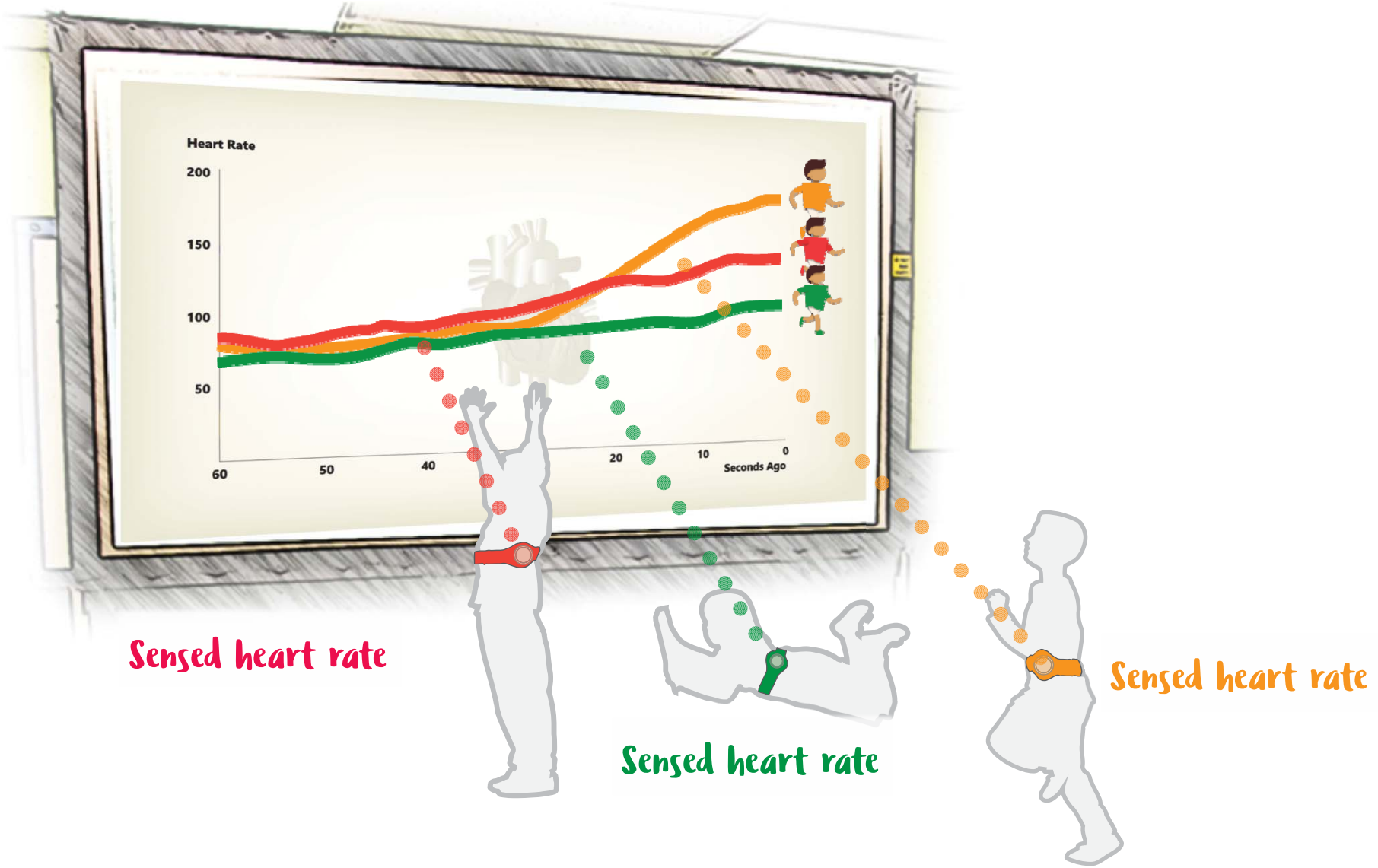
Design Goals



- Social comparison
- Hypothesis testing
- Basic statistics

Prototype #2: Moving Graphs

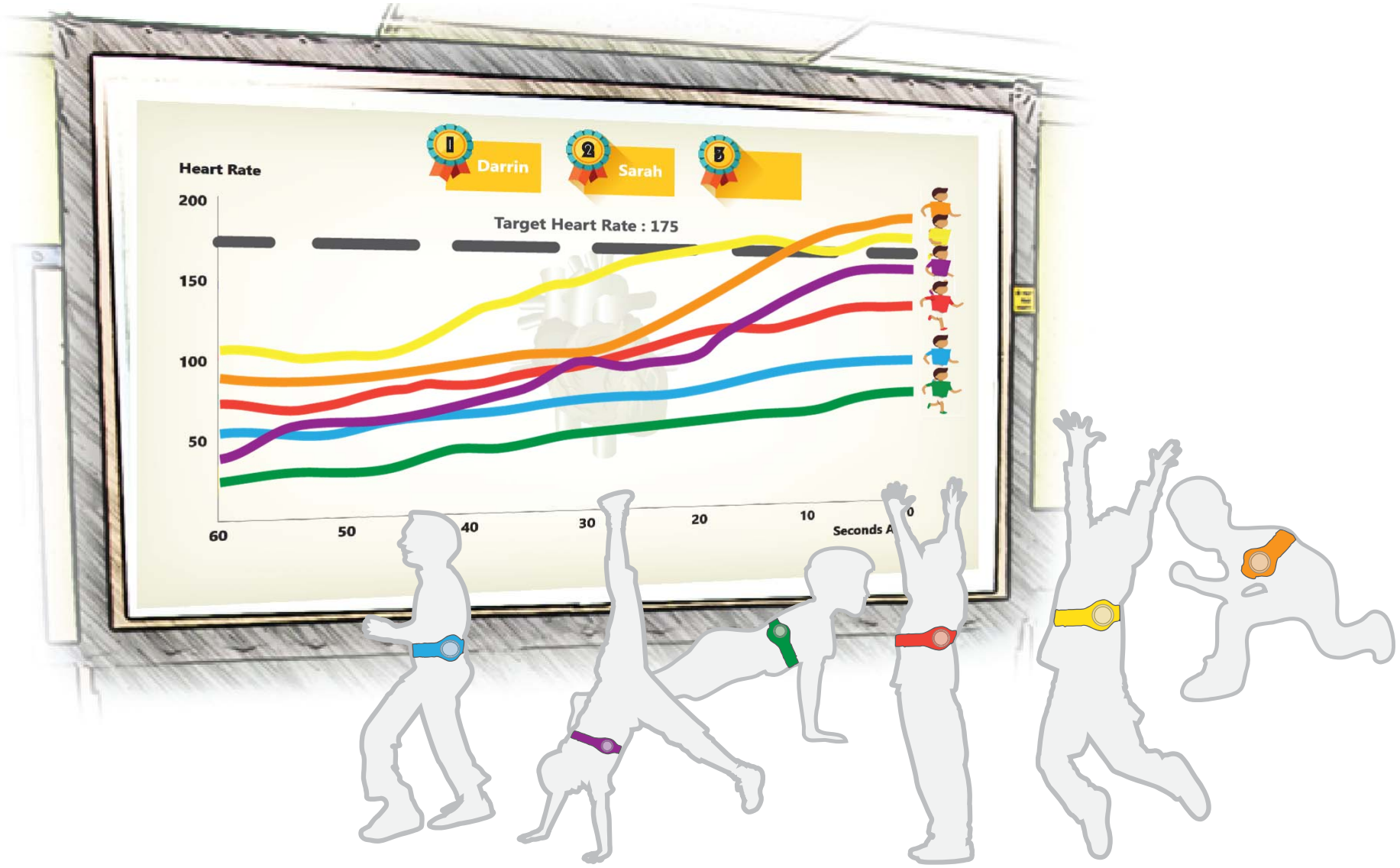
How It Works

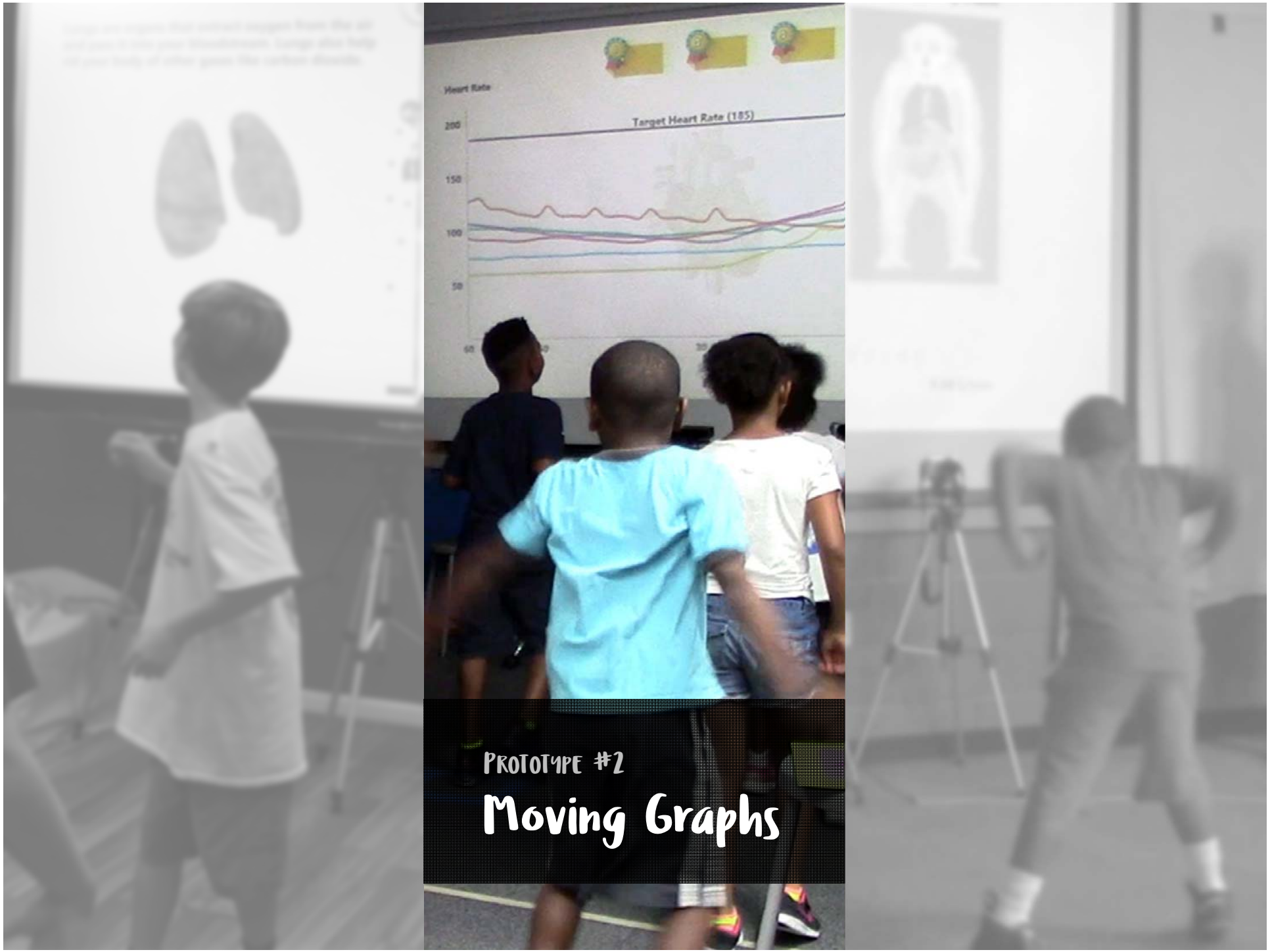


Hypothesis Generation

Prototype #2: Moving Graphs

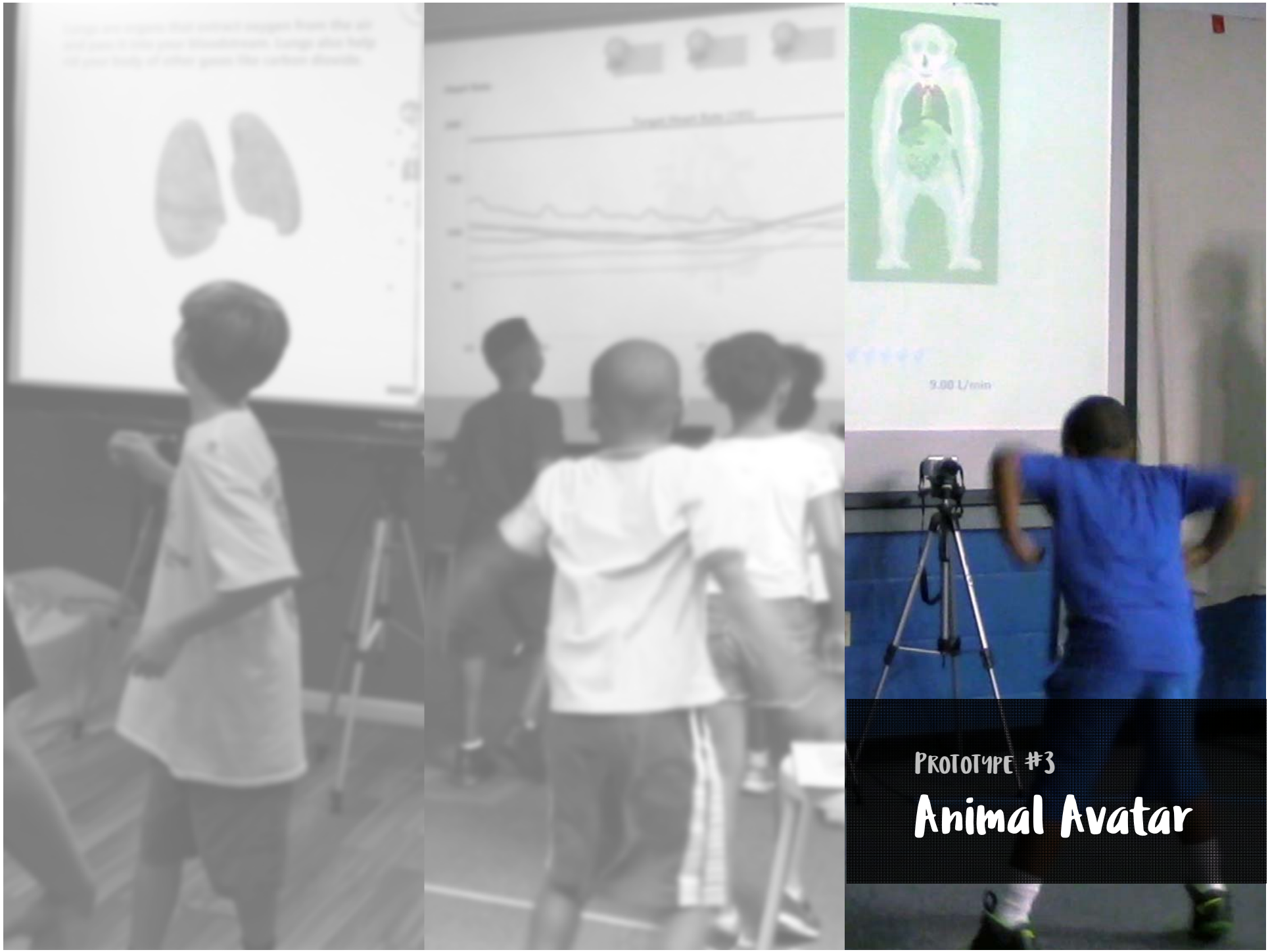
Hypothesis Testing





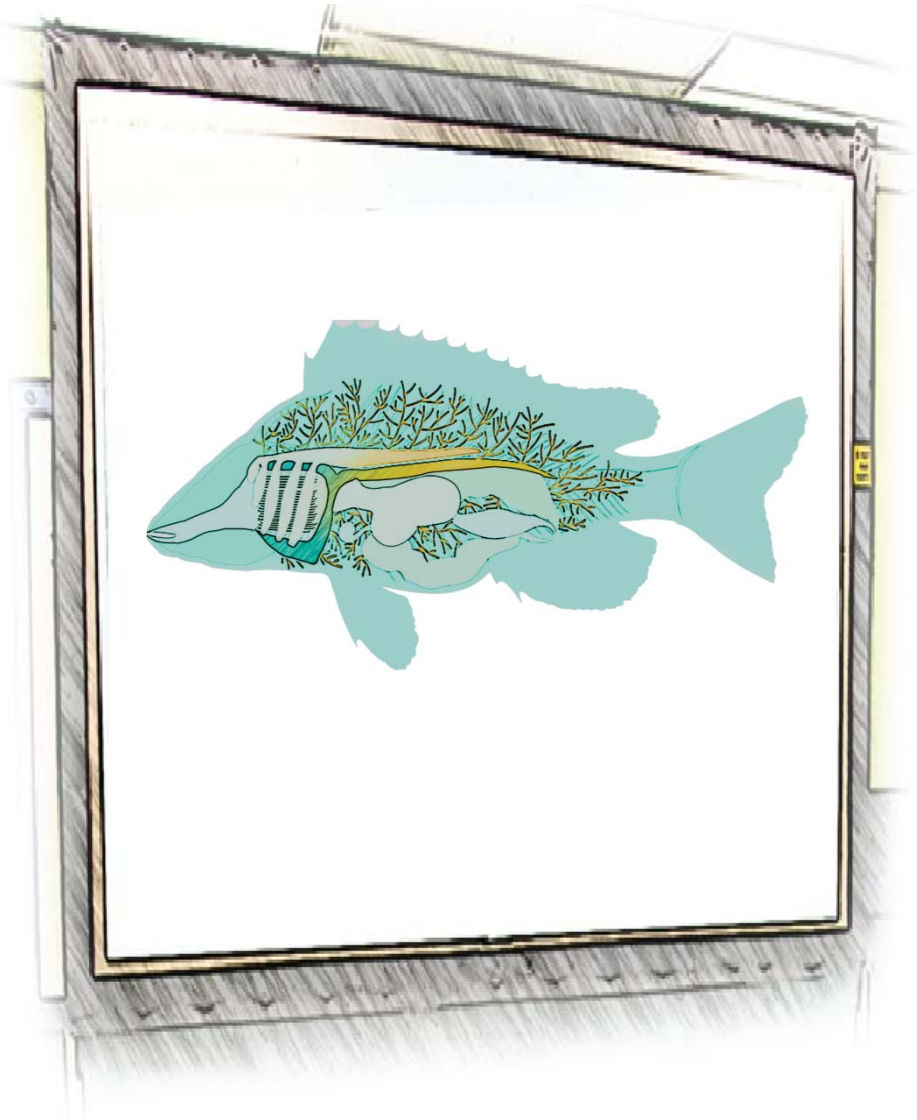
PROTOTYPE #2

Moving Graphs

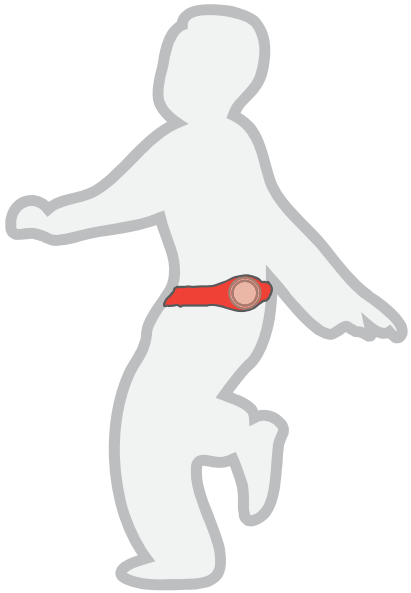

Prototype #3
Animal Avatar

Prototype #3: Animal Avatar

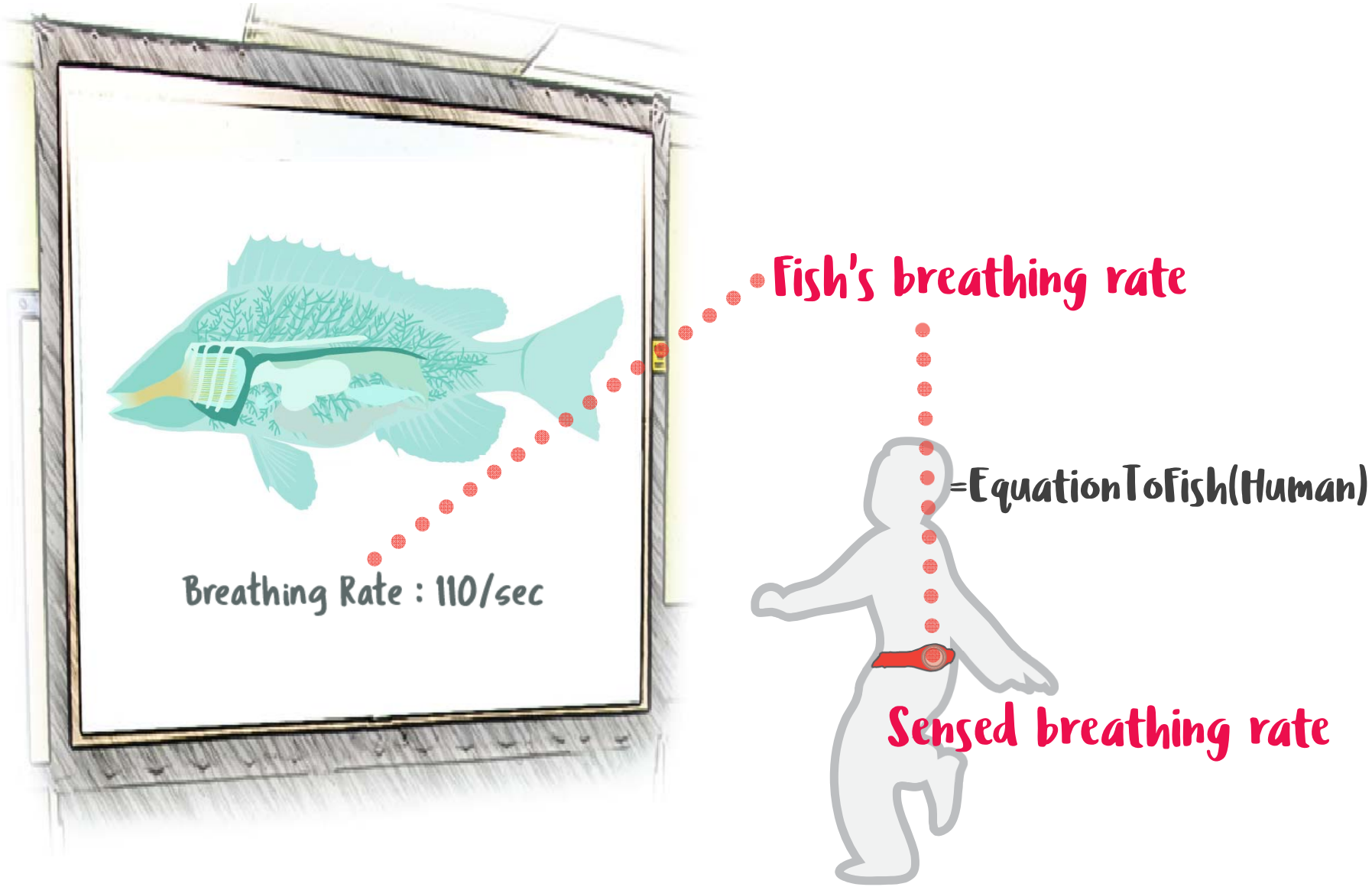
Design Goals



- Observation & Discovery
- Comparison & Contrast
- Cross-species Biology

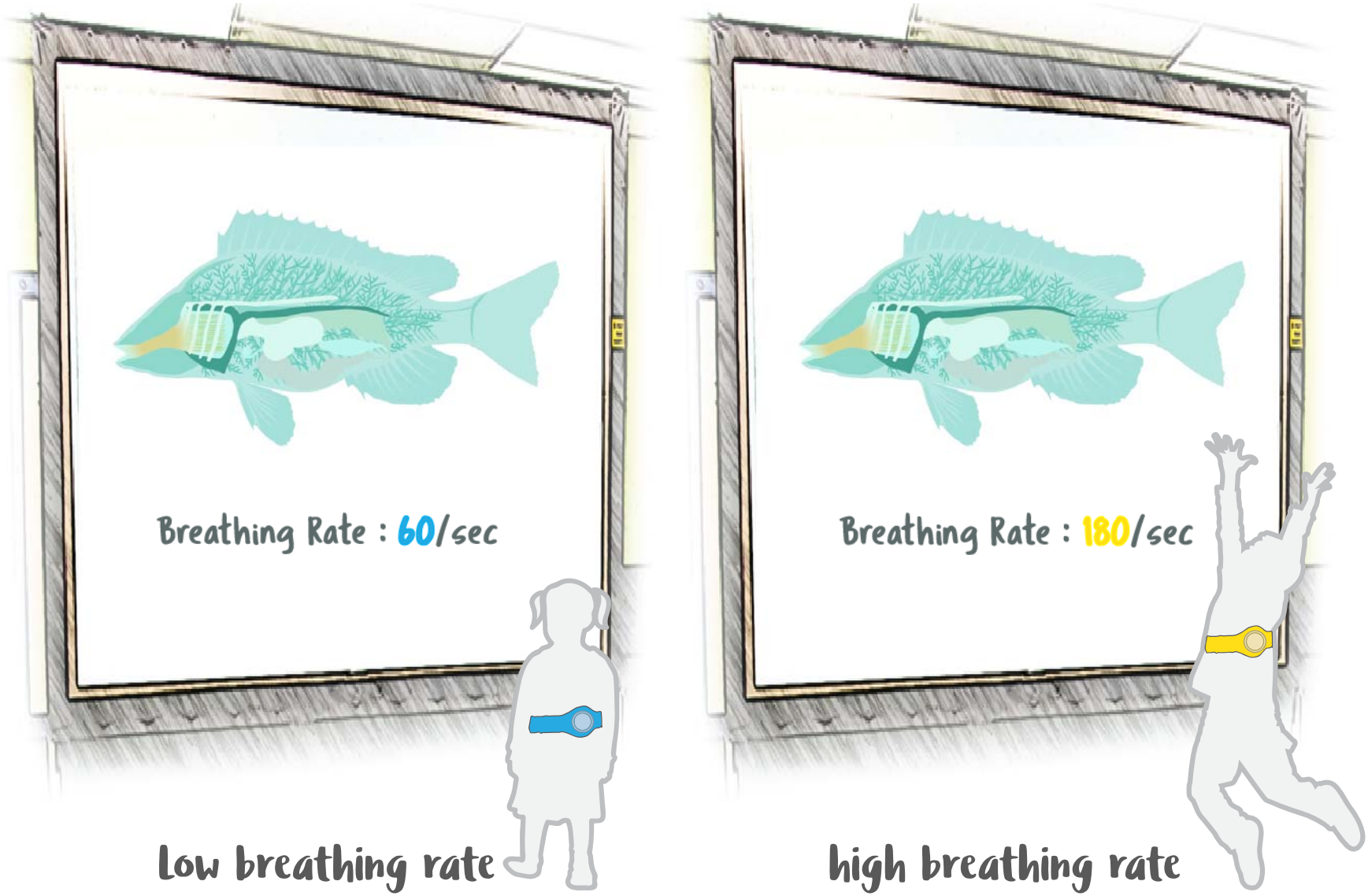


How It Works


Breathing Rate : 110/sec
Fish's breathing rate
=EquationToFish(Human)
Sensed breathing rate

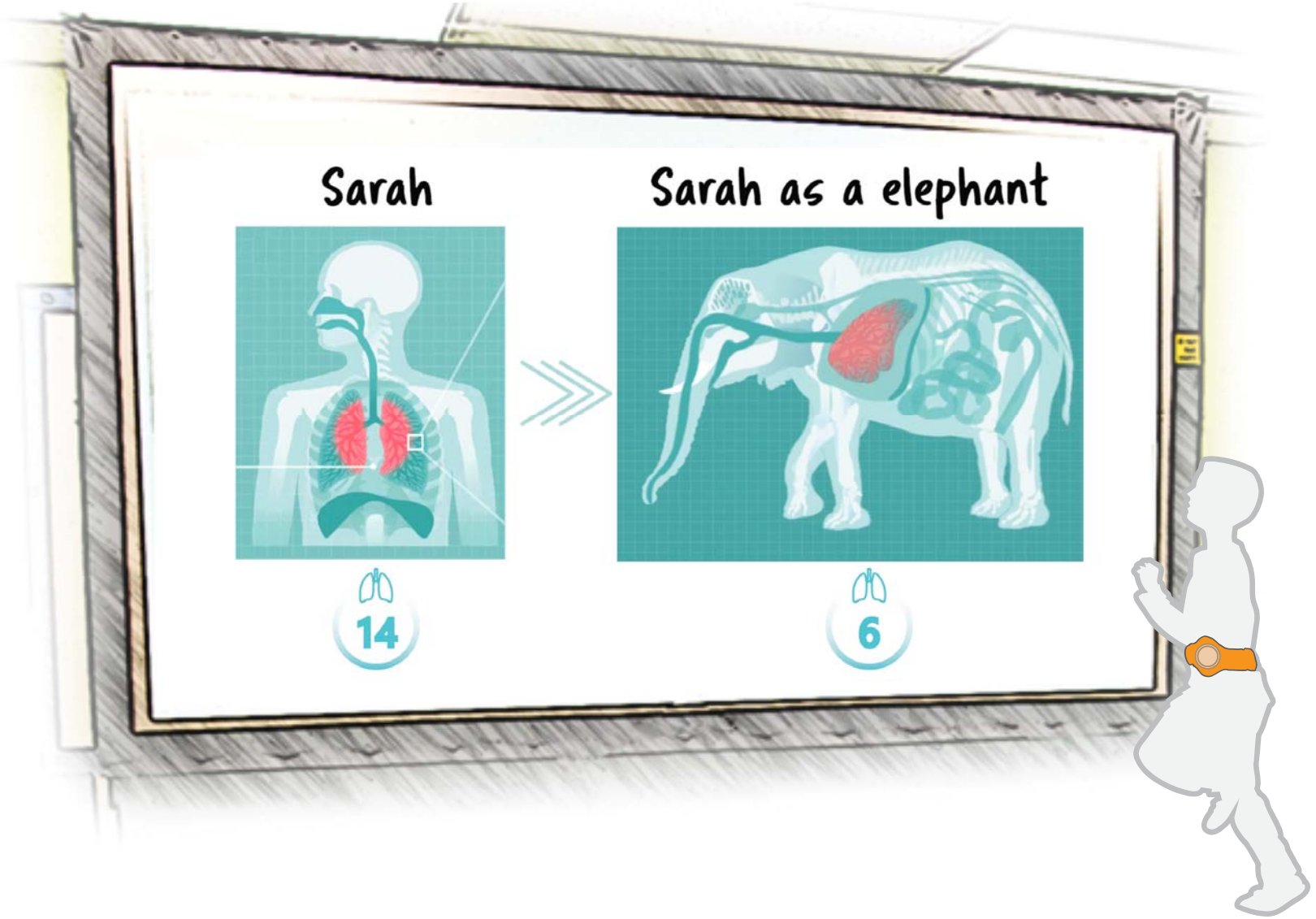
Prototype #3: Animal Avatar

How It Works



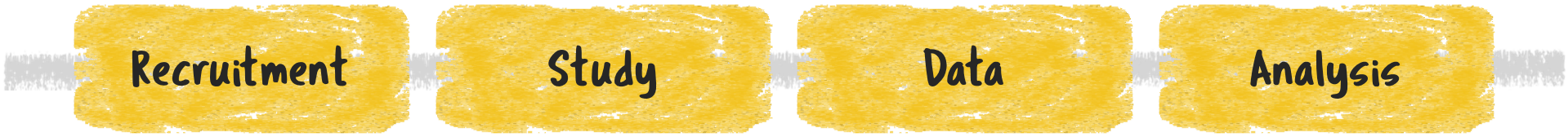
Prototype #3: Animal Avatar

Discovering Similarity and Difference



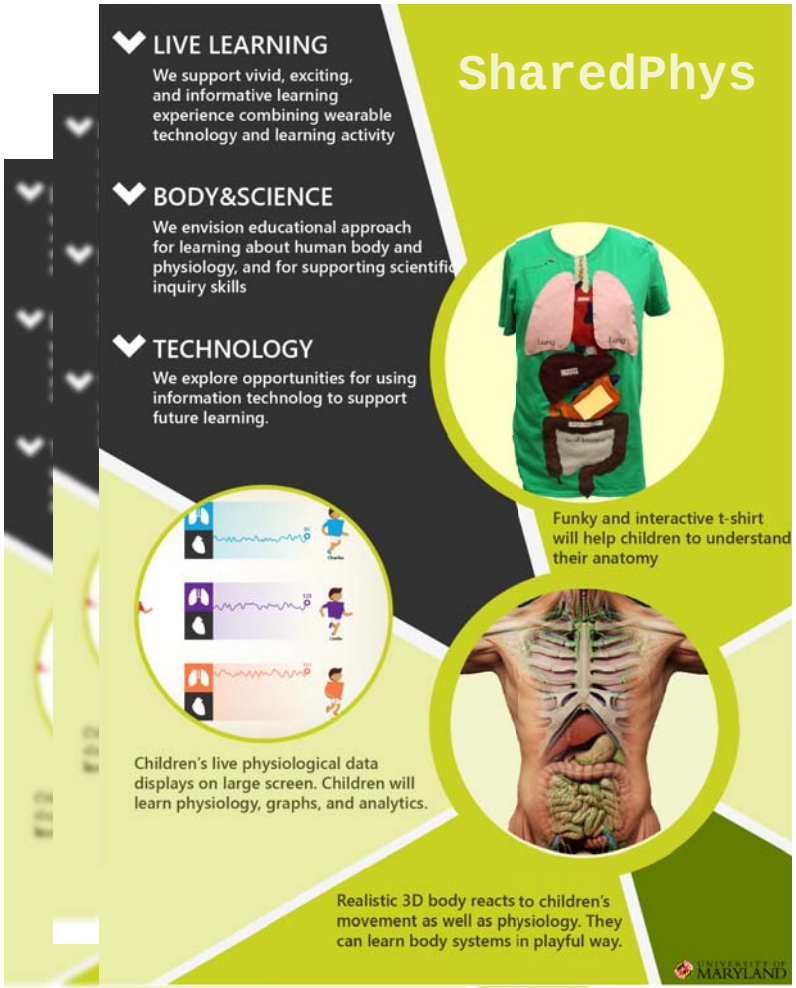
Evaluation

Qualitative exploration and soliciting feedback



EVALUATION

Recruitment



Two after-school programs

Evaluation

Recruitment

69 children participated
aged 5~13

Evaluation

Study

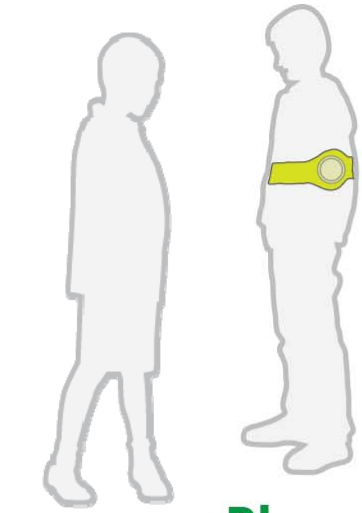
6 single sessions

2 hours

3 program staff

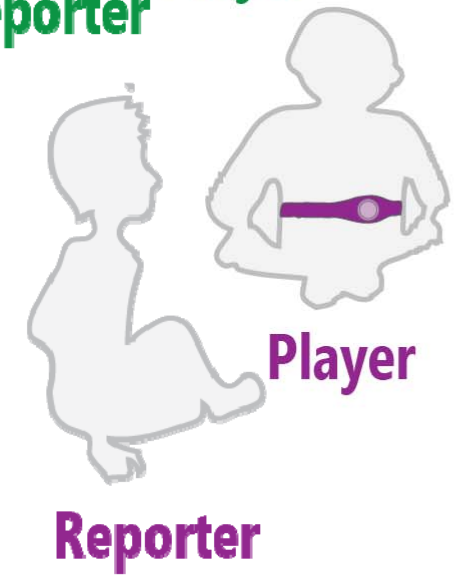
Players wear sensors

Reporters do NOT



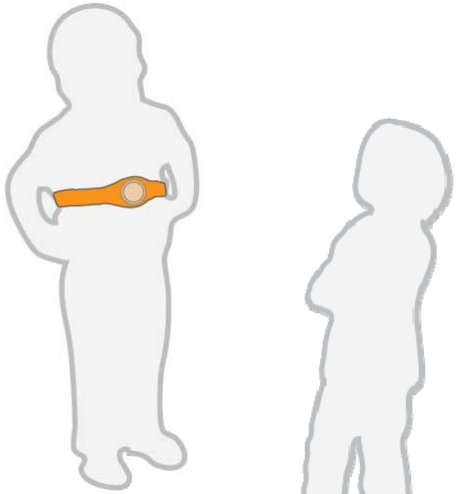
Reporter

Player



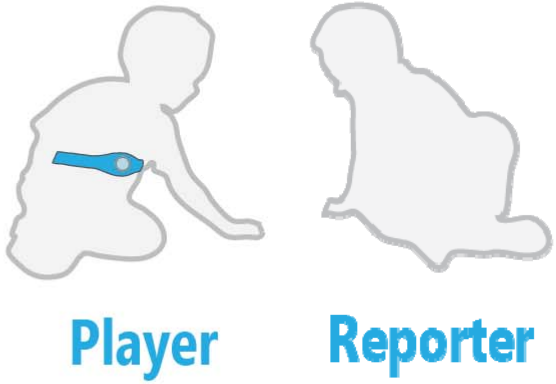
Player

Reporter



Player

Reporter

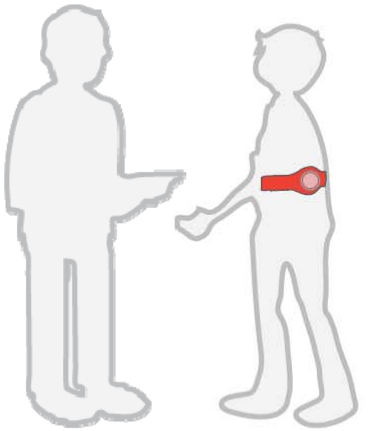


Player

Reporter

Reporter

Player



Reporter

Player

Evaluation

Data

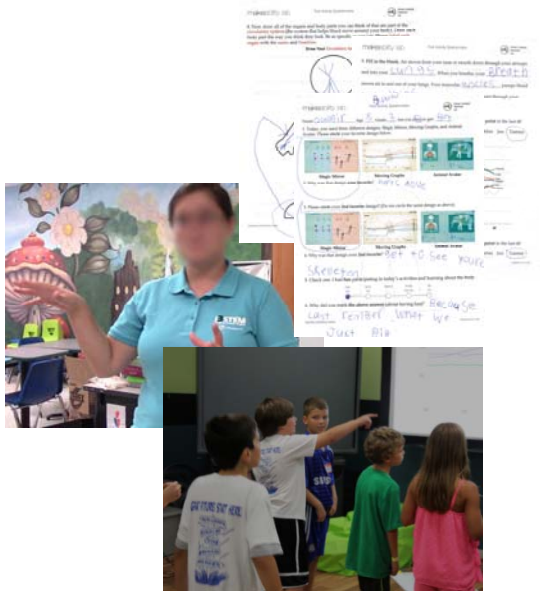
Pre&post-activitiy questionnaires

Video recordings

Program staff interview

Evaluation

Analysis



Codebook → Independent coding → Coding result (verified inter-rater reliability) → Summary

Researchers independently analyzed the data, iterating on codebook

Results

Design Preferences

Enjoyment

Physical Interactions

Learning Potential

Program Staff Feedback

Social Interactions

Results

Design Preferences

Enjoyment

Physical Interactions

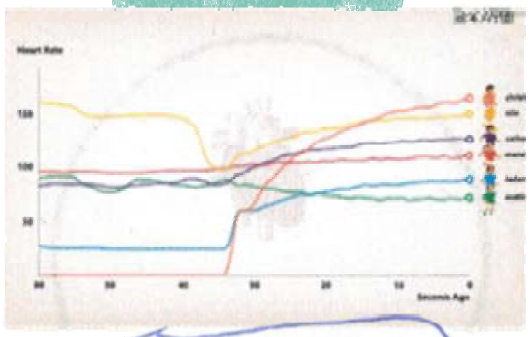
Learning Potential

Program Staff Feedback

Social Interactions

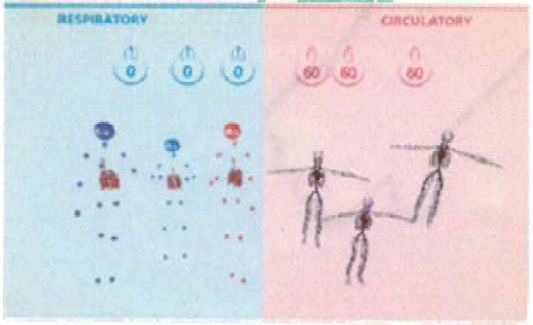
Design Preference

41%



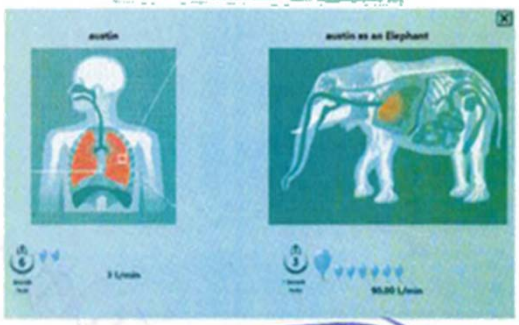
Moving Graphs

35%



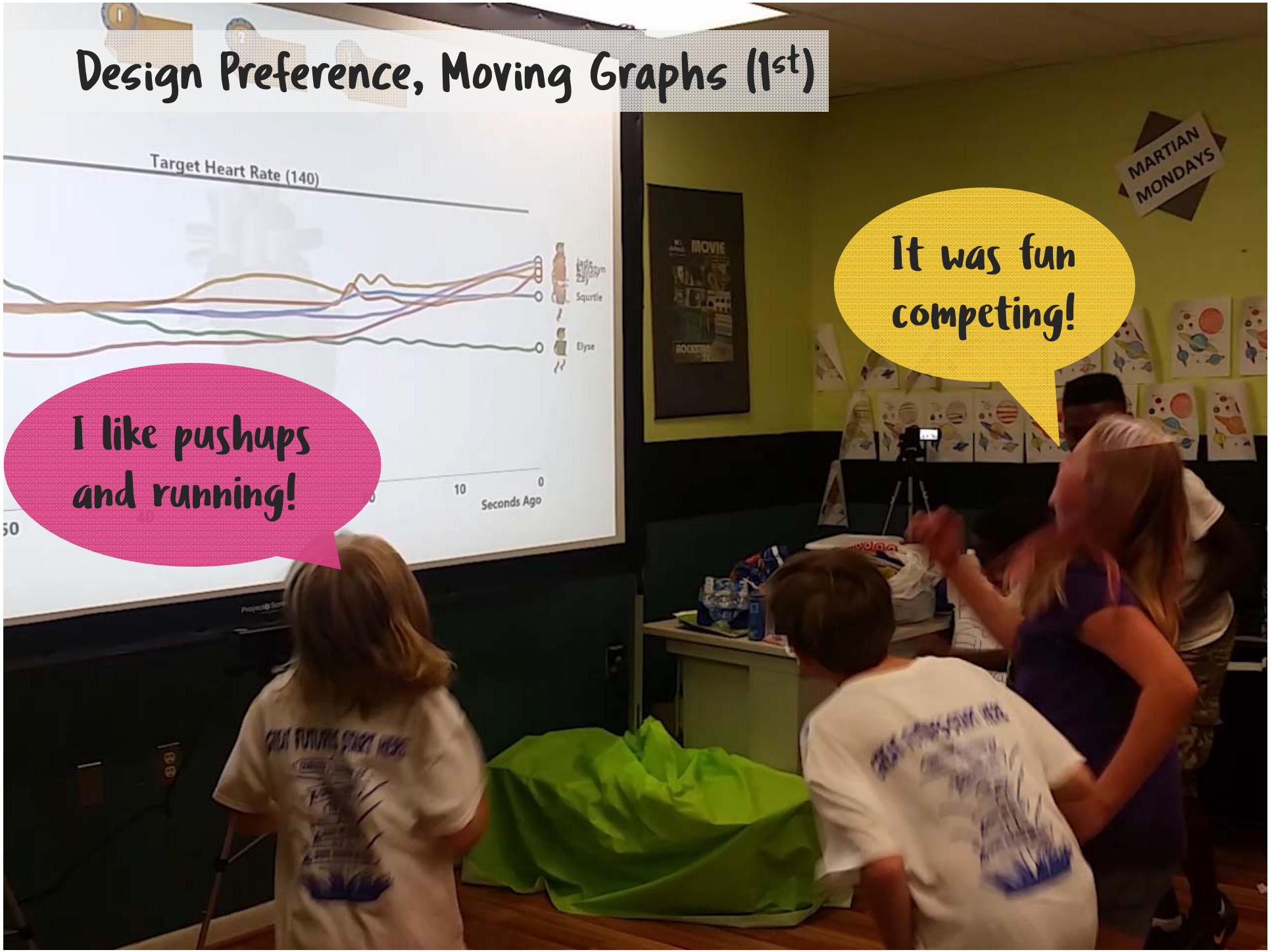
Magic Mirror

24%

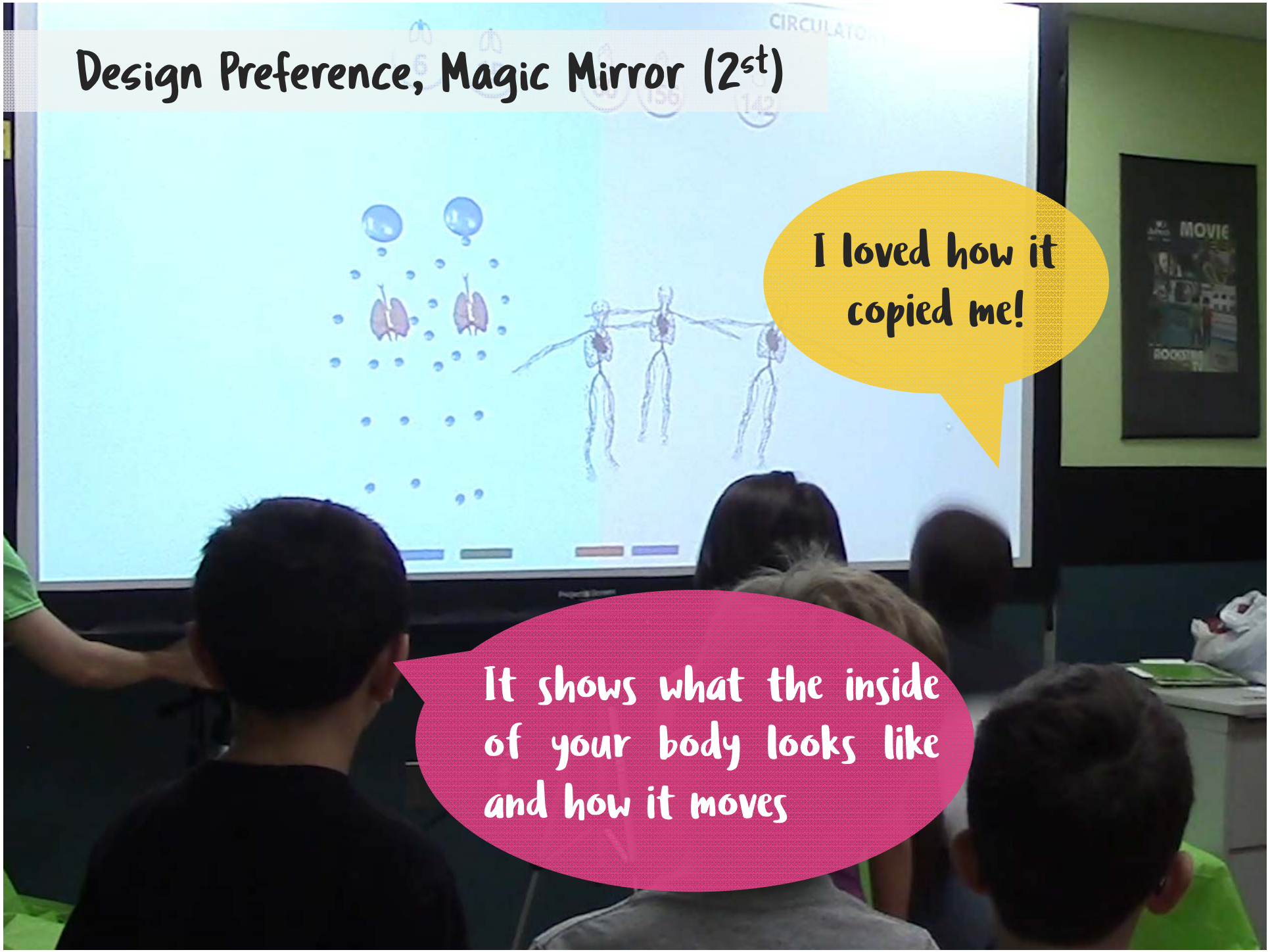


Animal Avatar

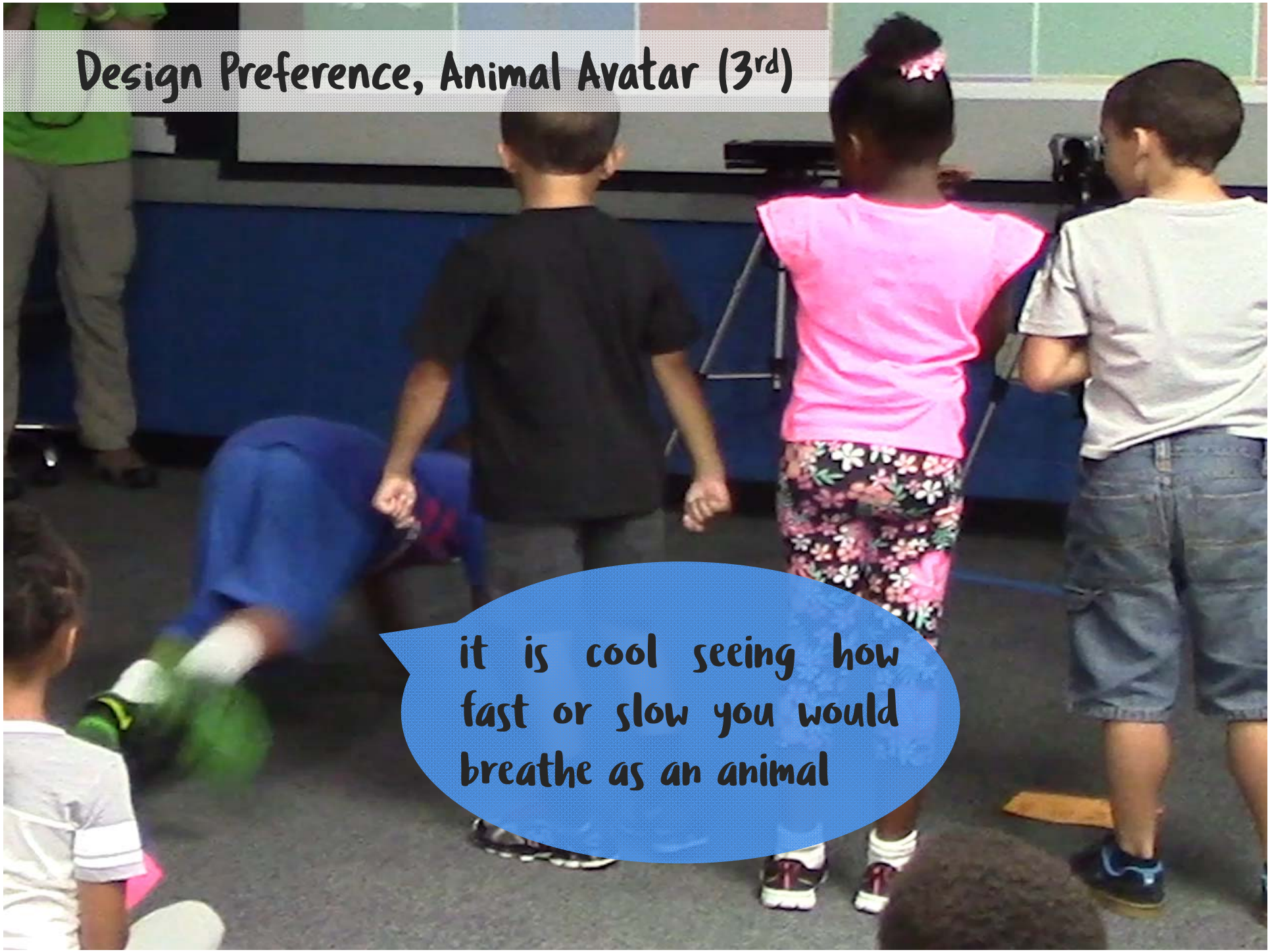
Design Preference, Moving Graphs (1st)



Design Preference, Magic Mirror (2st)



Design Preference, Animal Avatar (3rd)



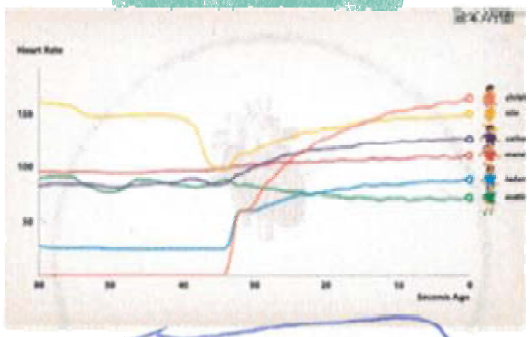
Design Preference

41%

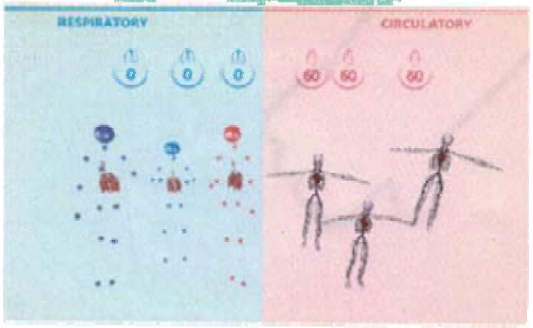
35%

24%

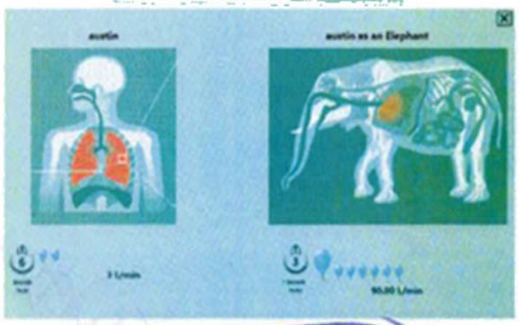
Children prefer designs with higher **physical activity**



Moving Graphs



Magic Mirror



Animal Avatar

Results

Design Preferences

Enjoyment

Physical Interactions

Learning Potential

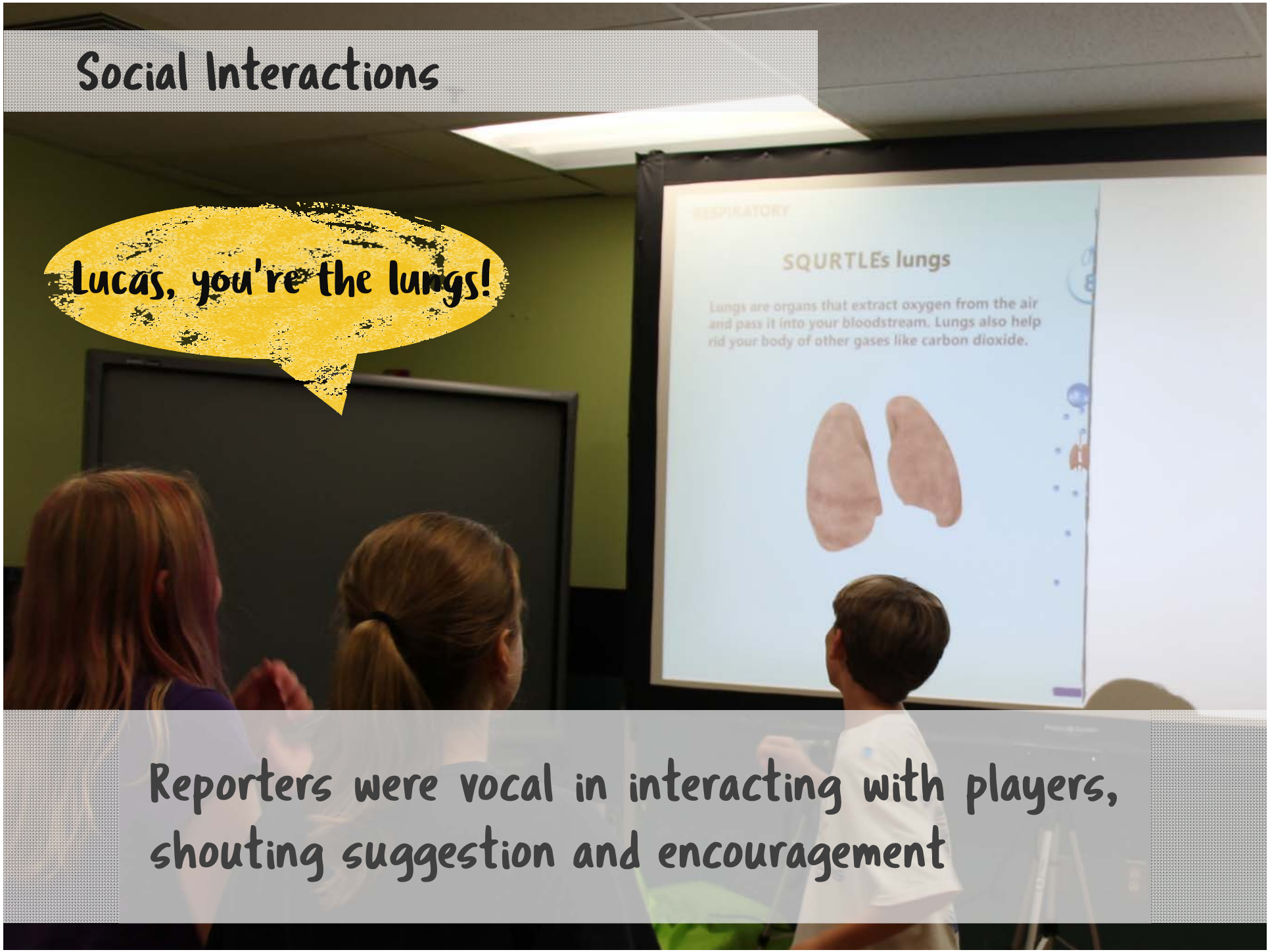
Program Staff Feedback

Social Interactions

Social Interactions

Players interact non-verbally by physical interaction and data comparison

Social Interactions



Reporters were vocal in interacting with players, shouting suggestion and encouragement

Social Interactions

Reporters were vocal in interacting with players, shouting suggestion and encouragement

Results

Design Preferences

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Learning Potential

makeability lab Pre-Activity Questionnaire

2. Now draw all of the organs and body parts you can think of that are part of the circulatory system (the system that helps blood move around your body). Draw each body part the way you think they look. Be as specific as you can. Please label each organ with the name and function.

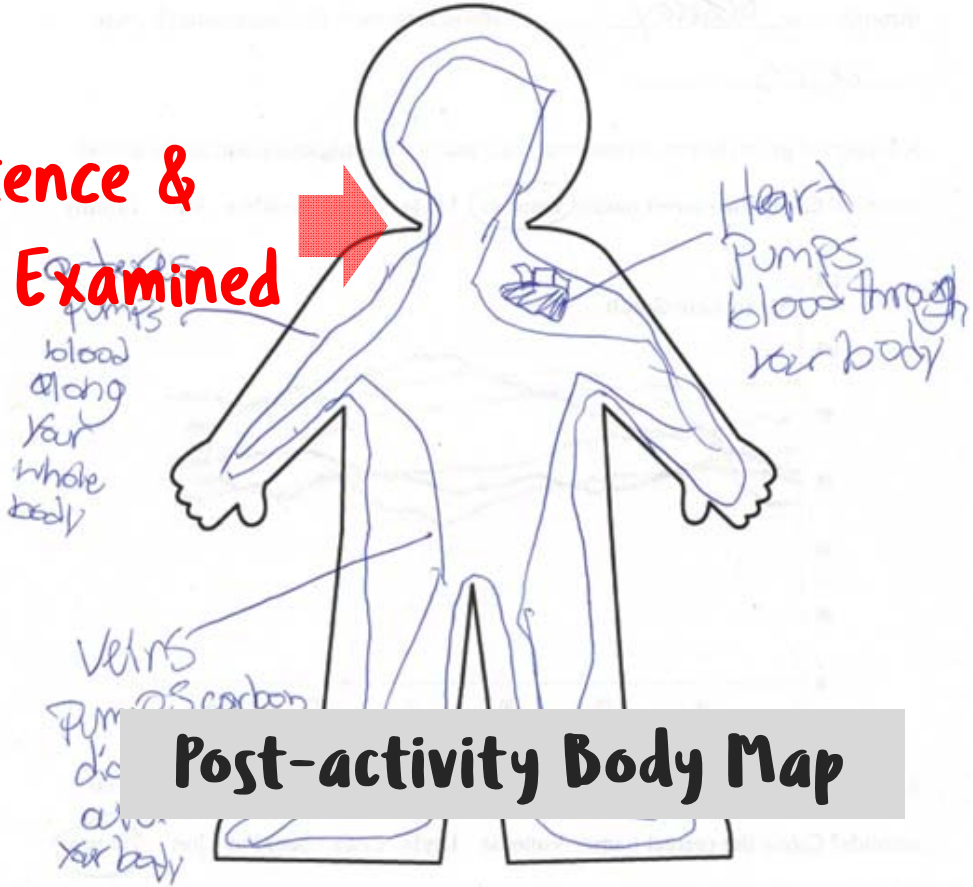
Draw Your Circulatory System

Existence & Position Examined

makeability lab Post-Activity Questionnaire

6. Now draw all of the organs and body parts you can think of that are part of the circulatory system (the system that helps blood move around your body). Draw each body part the way you think they look. Be as specific as you can. Please label each organ with the name and function.

Draw Your Circulatory System



Pre-activity Body Map

Post-activity Body Map

Learning Potential

makeability lab Pre-Activity Questionnaire

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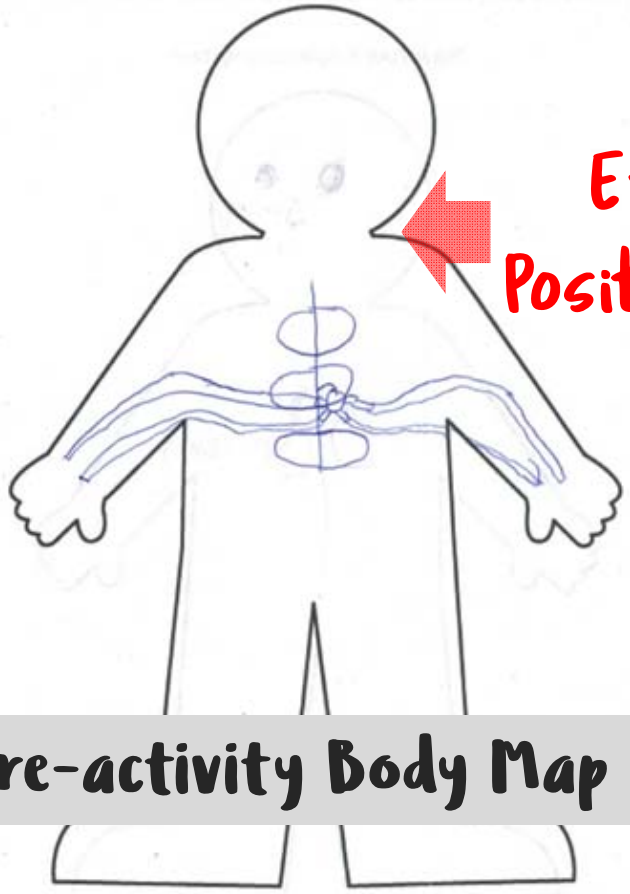

Pre-activity Body Map

Existence &
Position Examined

makeability lab Post-Activity Questionnaire

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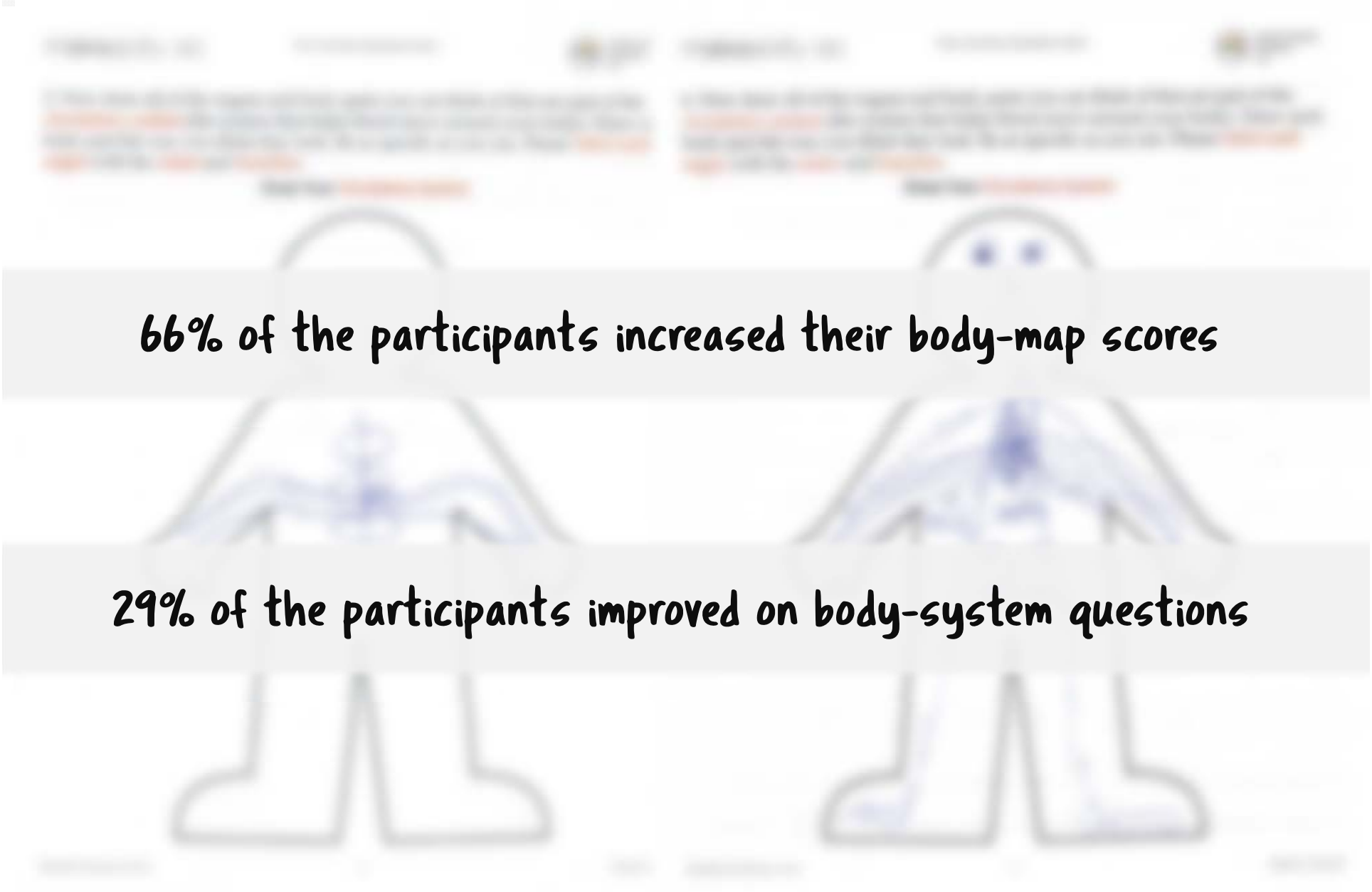
Draw Your Circulatory System

Post-activity Body Map

Learning Potential



66% of the participants increased their body-map scores

29% of the participants improved on body-system questions

Results

Design Preferences

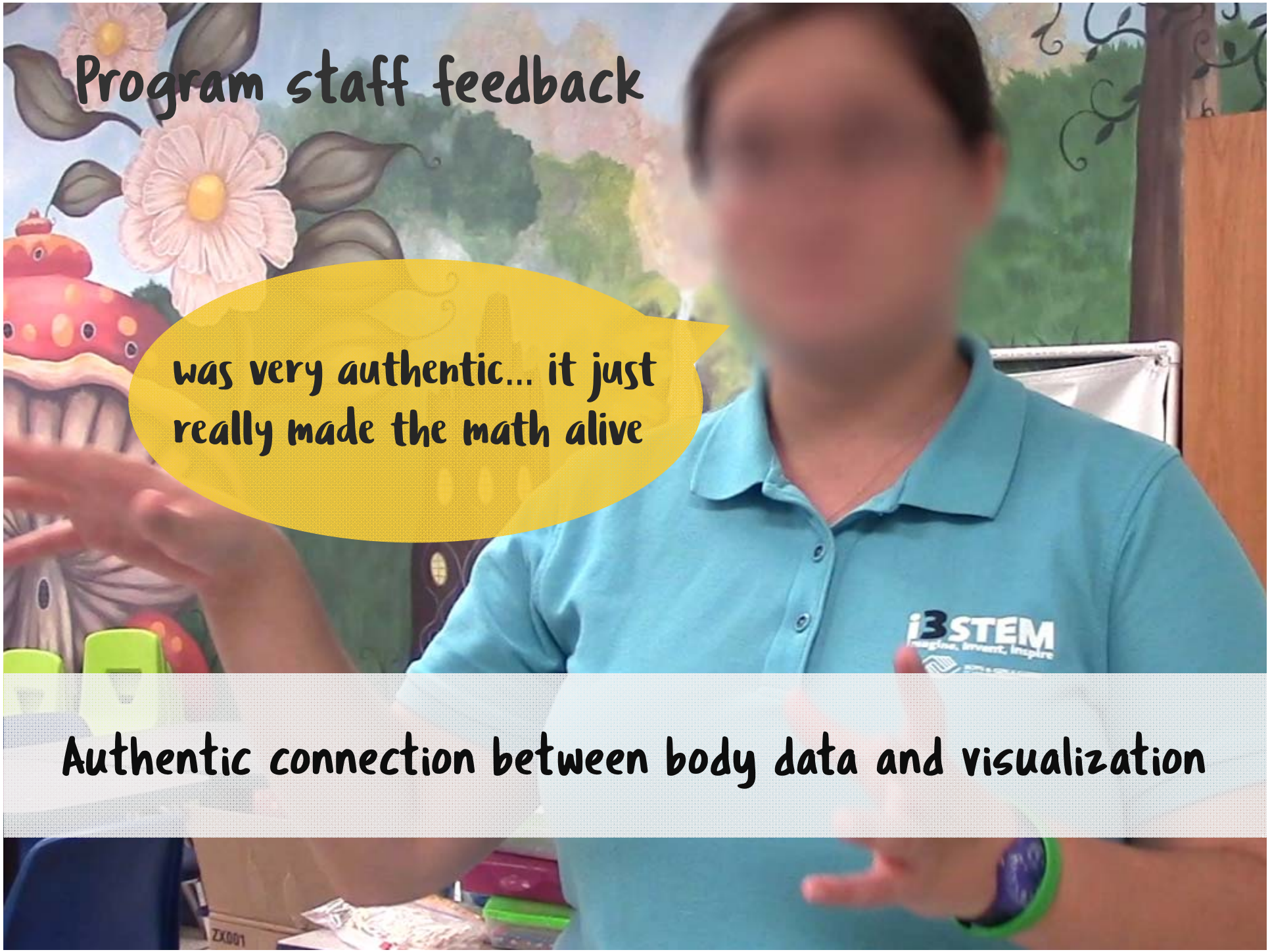
Enjoyment

Physical Interactions

Learning Potential

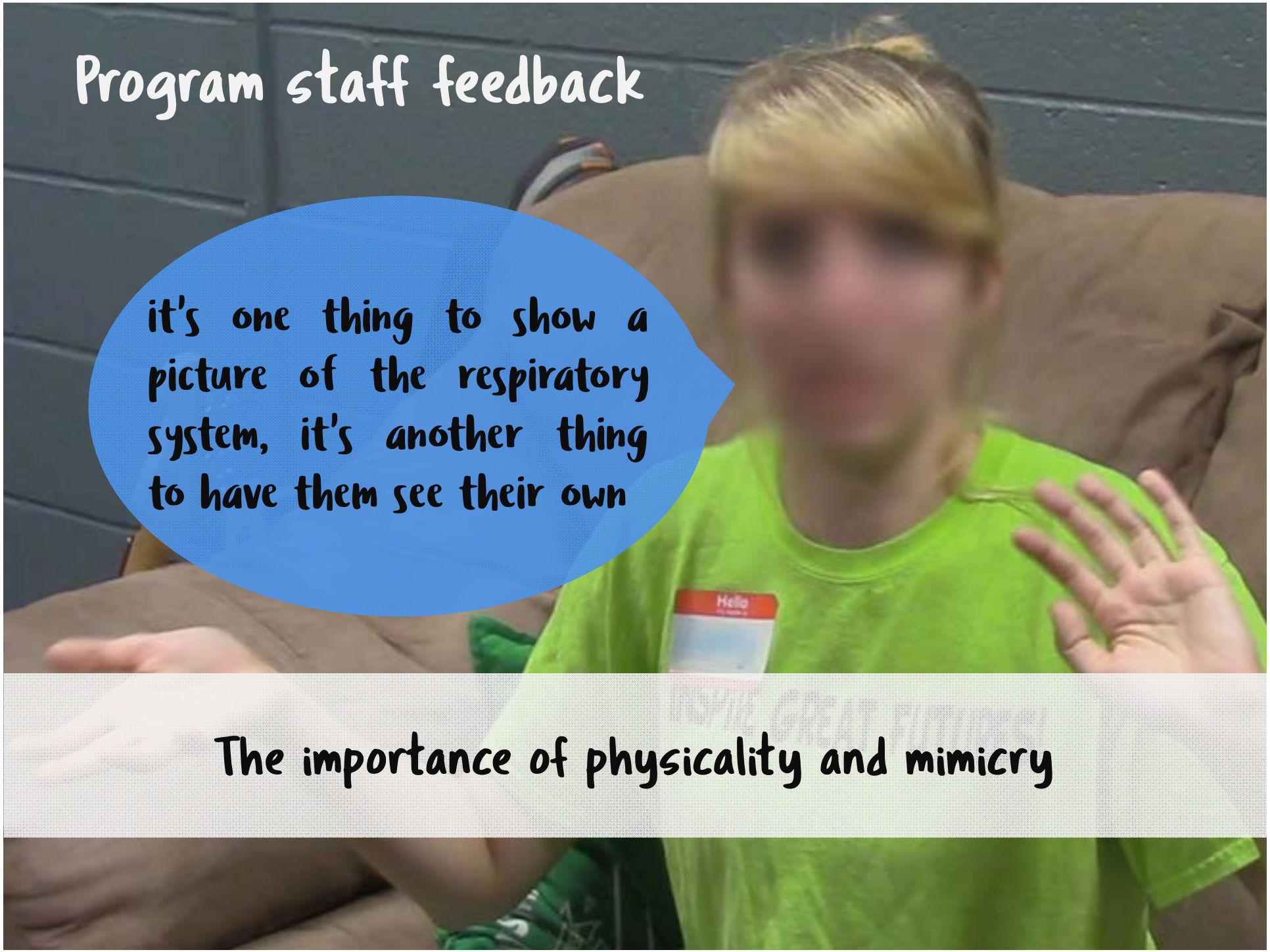
Social Interactions

Program staff feedback



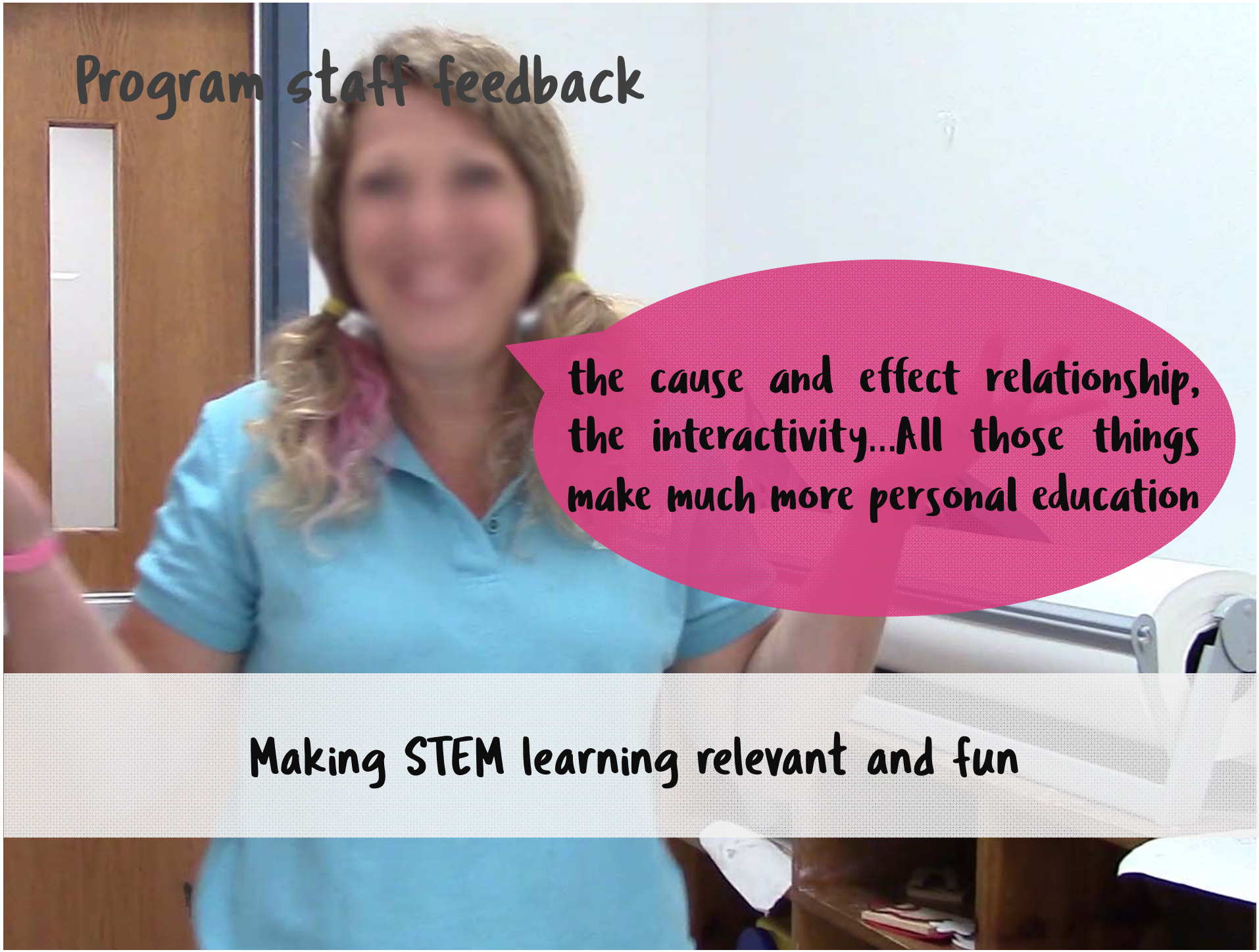
Authentic connection between body data and visualization

Program staff feedback



The importance of physicality and mimicry

Program staff feedback



Making STEM learning relevant and fun

Discussion

- ✓ **NO** difference in engagement and learning between wearers and **non-wearer**
- ✓ **Non-verbal communication** afforded by shared environment & physical interaction
- ✓ **In situ** body data collecting, hypothesis testing, and analysis **engaged children in scientific inquiry activity**

Summary

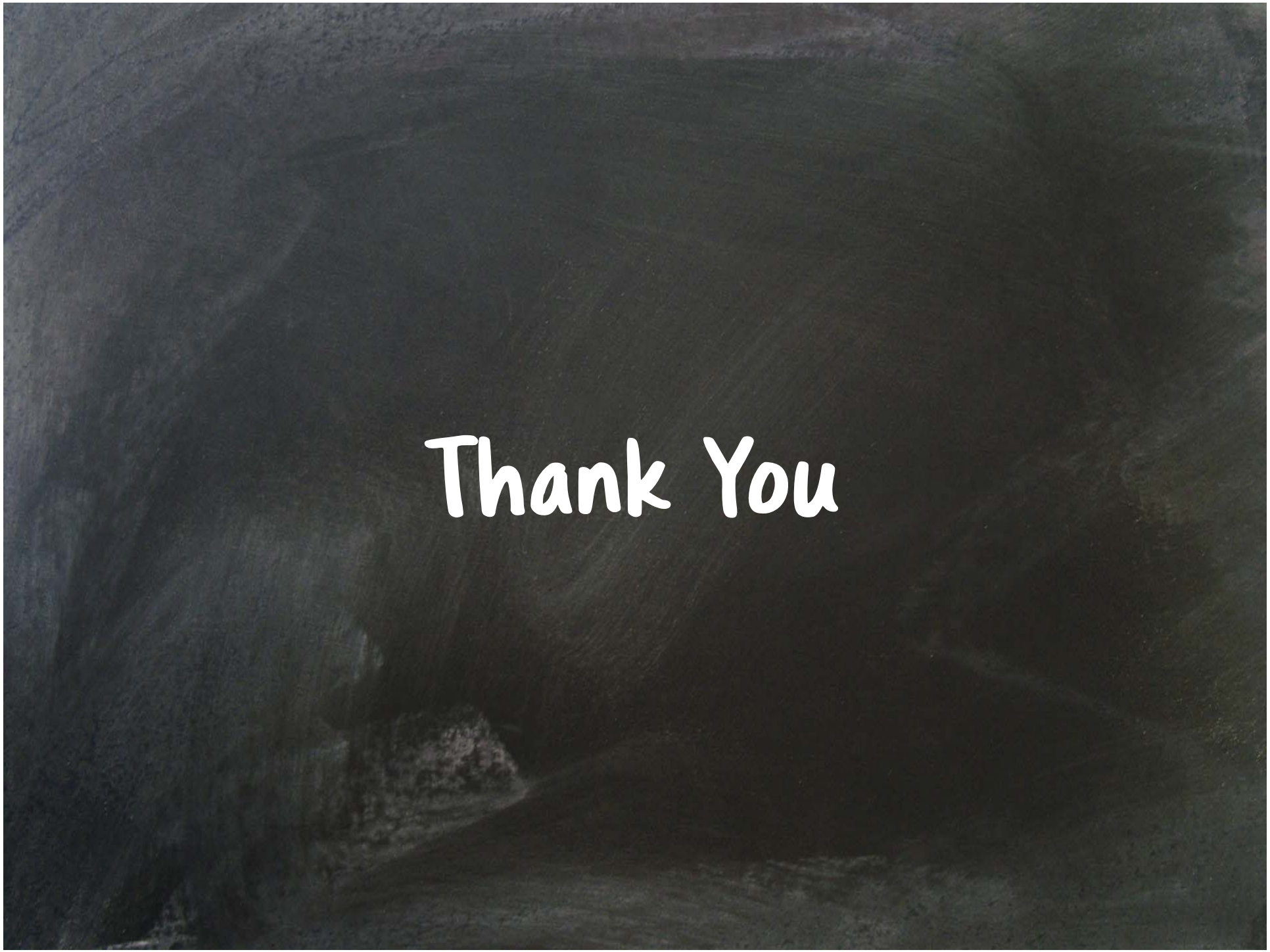
SharedPhys maps out and probe design space for

1) mixed-reality environments to support embodied interaction and learning

2) body-centric technology for inquiry activity.

Our results suggest benefits in

1) tight coupling between action and visualizations
2) social interactions afforded by shared environment
3) interplay between wearers and non-wearers


Thank You