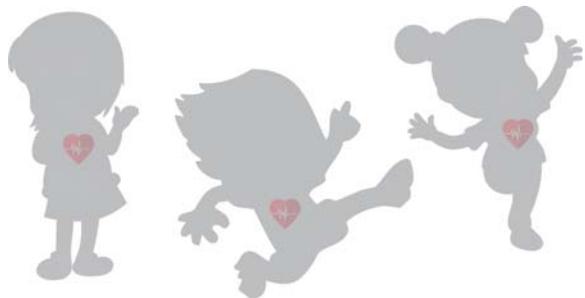


# SHAREDPHYS

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



**Seokbin Kang**, Leyla Norooz, Vanessa Oguamanam,  
Angelisa Plane, Tamara L. Clegg, Jon E. Froehlich

UNIVERSITY OF  
MARYLAND



COMPUTER SCIENCE  
UNIVERSITY OF MARYLAND

makeability lab



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.

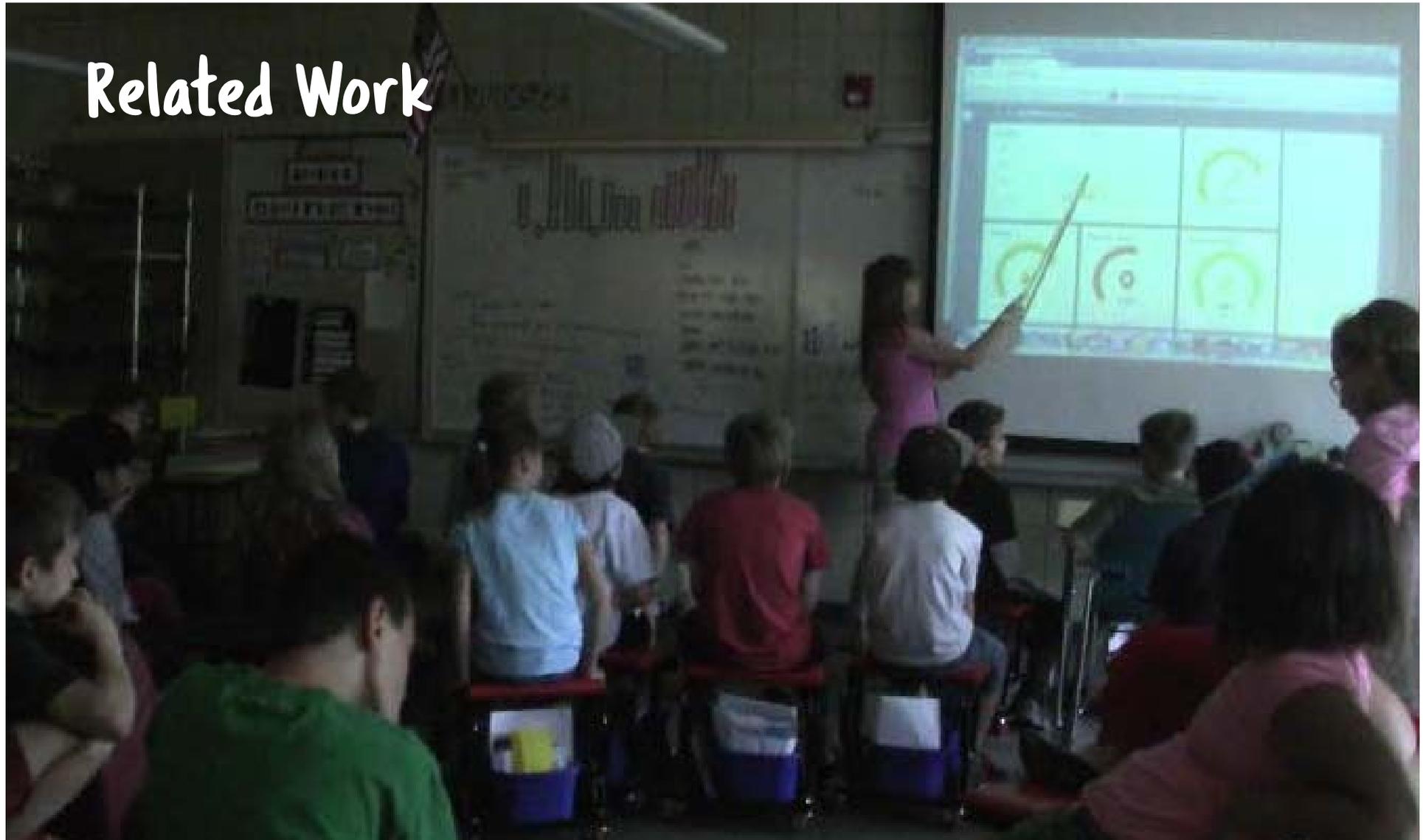
Lee et al. (2015, 2009)

## Related Work

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

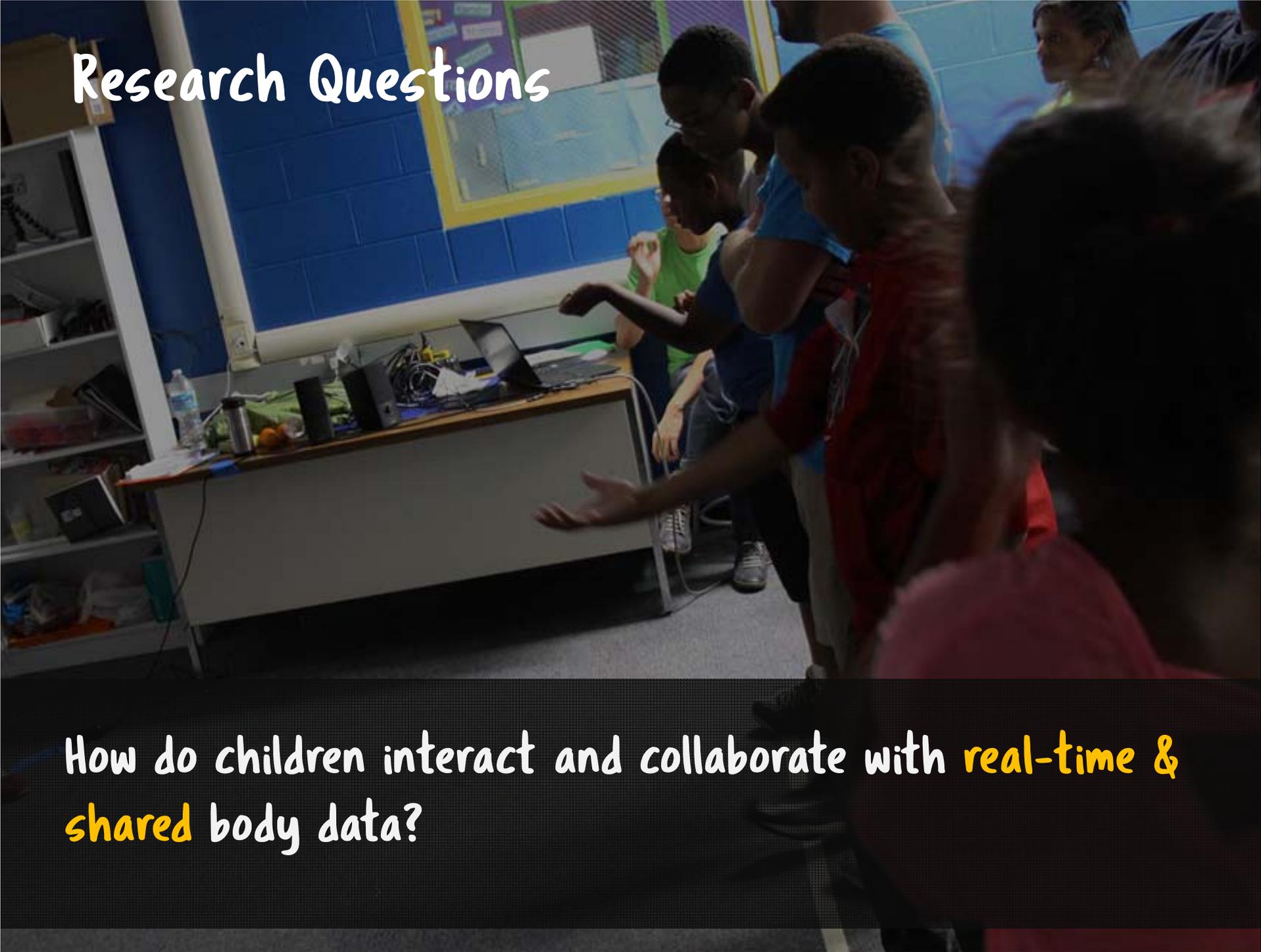
Lee et al. (2015, 2009)

# Related Work

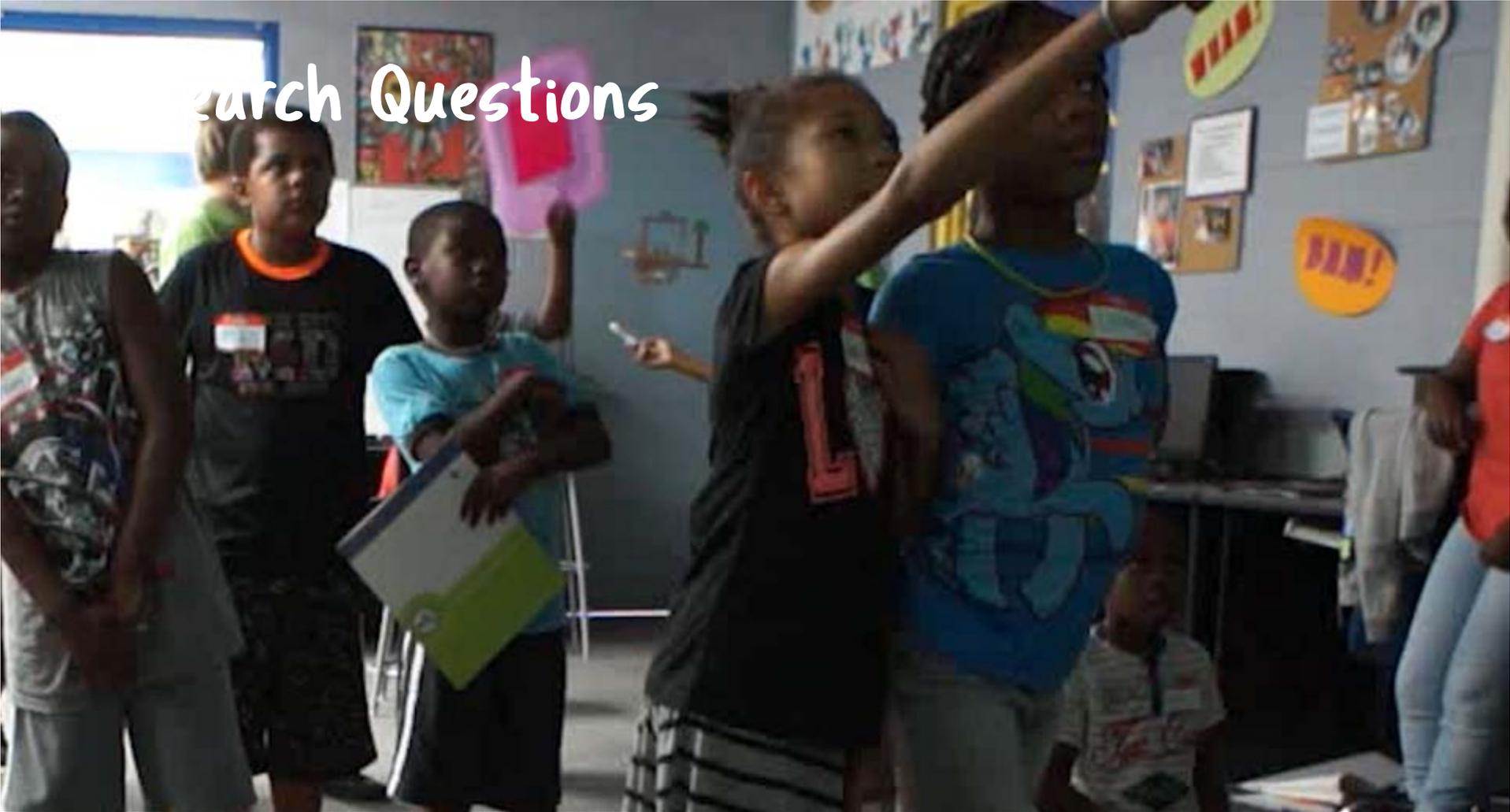


limited to using offline data, and having physical activity and learning separated.

# Research Questions

A group of children are gathered around a desk in a classroom. One child is pointing at a laptop screen while others look on. The room has blue walls and a bulletin board in the background.

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

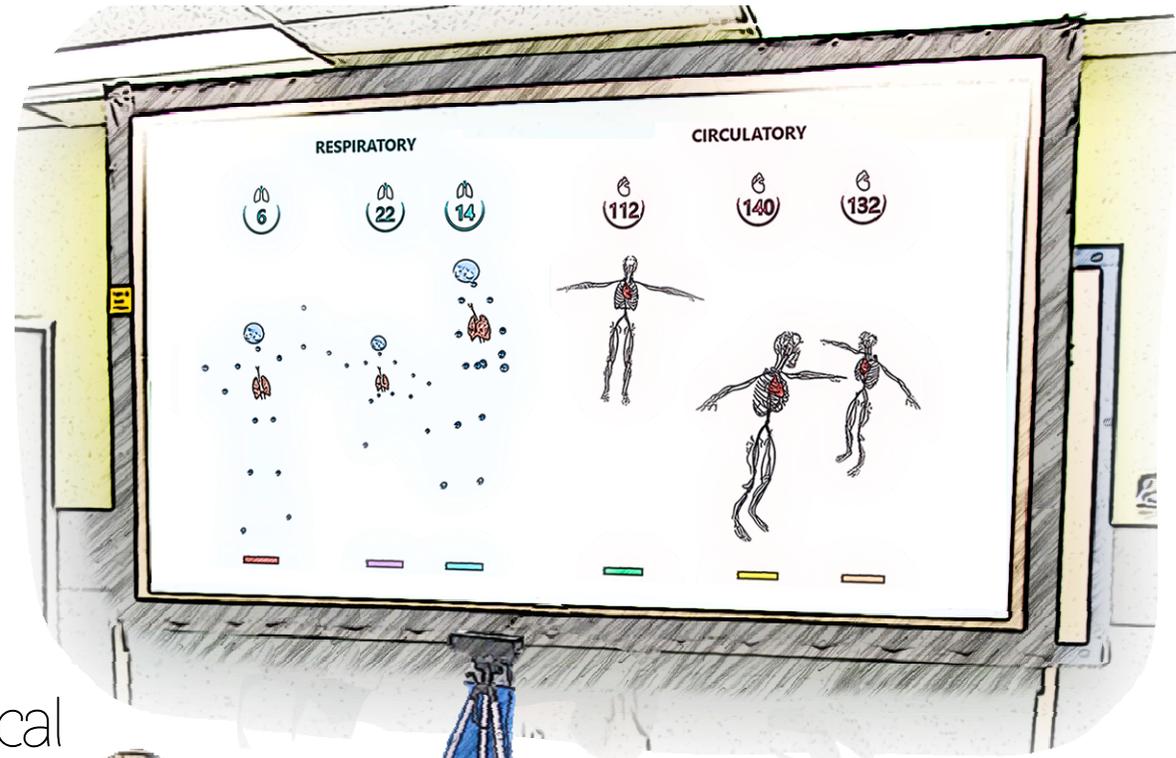


# Research Questions

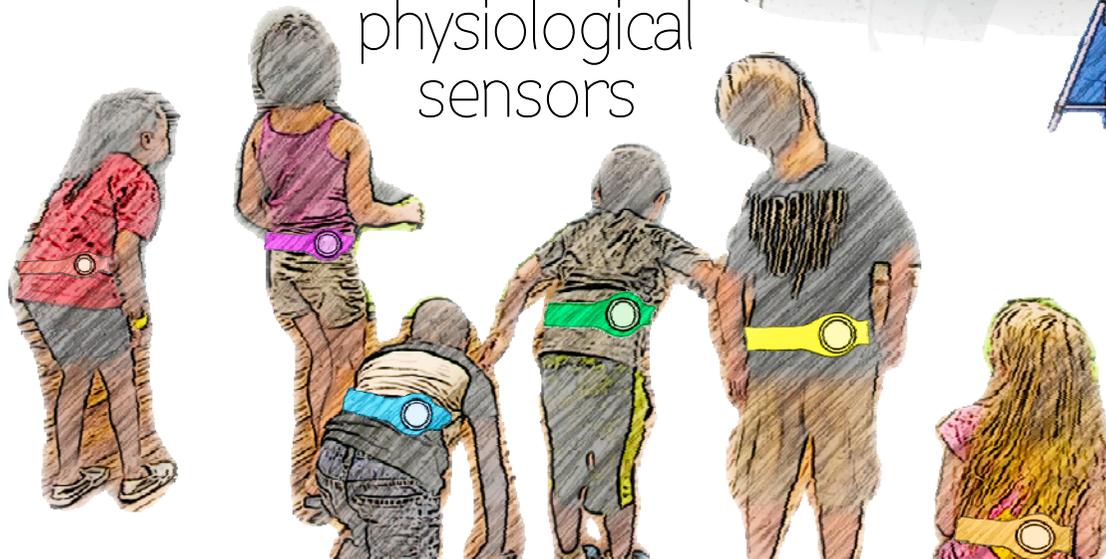
What aspects of designs and activities could **promote inquiry and engagement?**

# SharedPhys, Mixed-Reality Learning Environment

large display

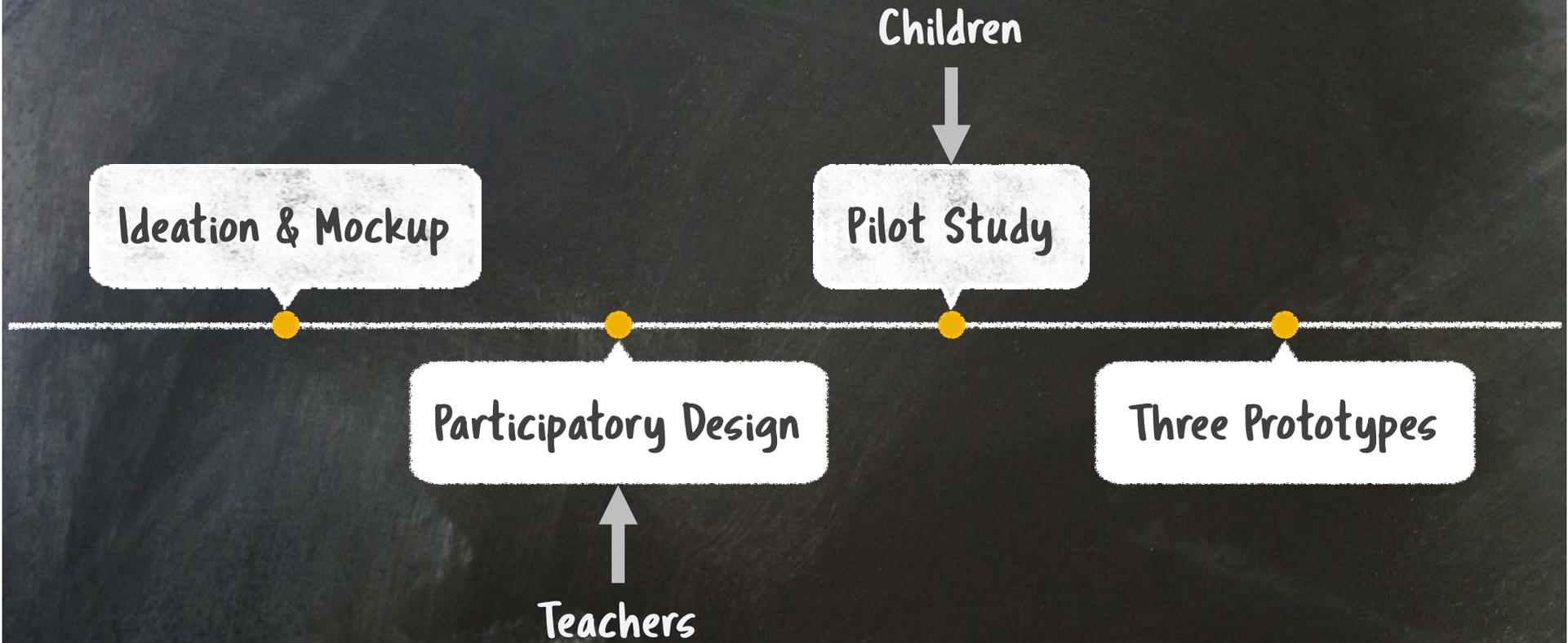


physiological sensors



kinect camera

# Design Process



# Design Process

Ideation & Mockup

Pilot Study

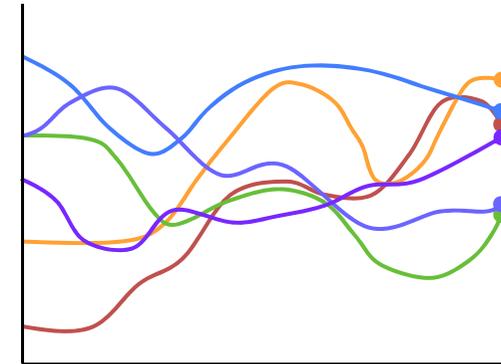
Participatory Design

Three Prototypes

# Heart Rate

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

## Group Averages



Highest  
Bob: 141

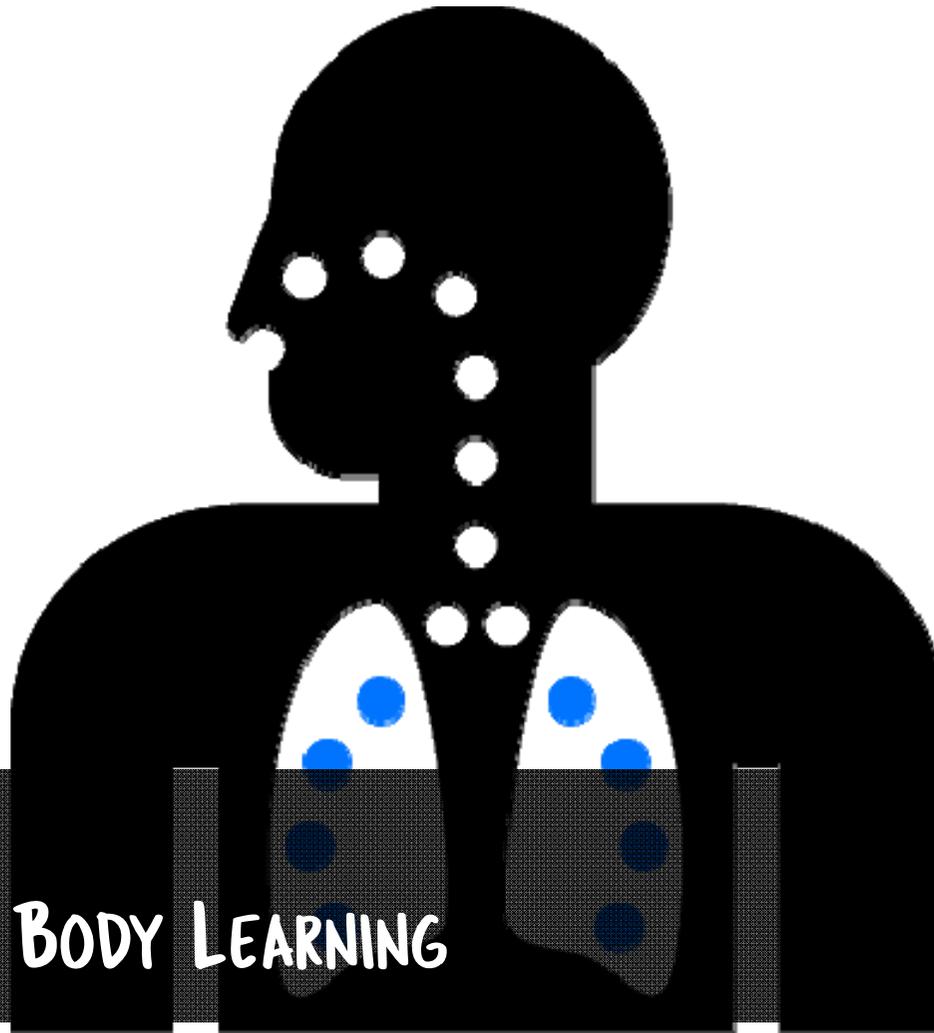
Lowest  
Jill: 95

Average  
XXX

MOCKUP EXAMPLE 1

SOCIAL COMPARISON OF LIVE BODY DATA

# Breathing Rate



MOCKUP EXAMPLE 2  
CONNECT WITH BODY LEARNING

# Design Process

Ideation & Mockup

Pilot Study

Participatory Design

Three Prototypes

# Design Process

Ideation & Mockup

Pilot Study

Participatory Design

Three Prototypes

DESIGN PROCESS

# Participatory Design

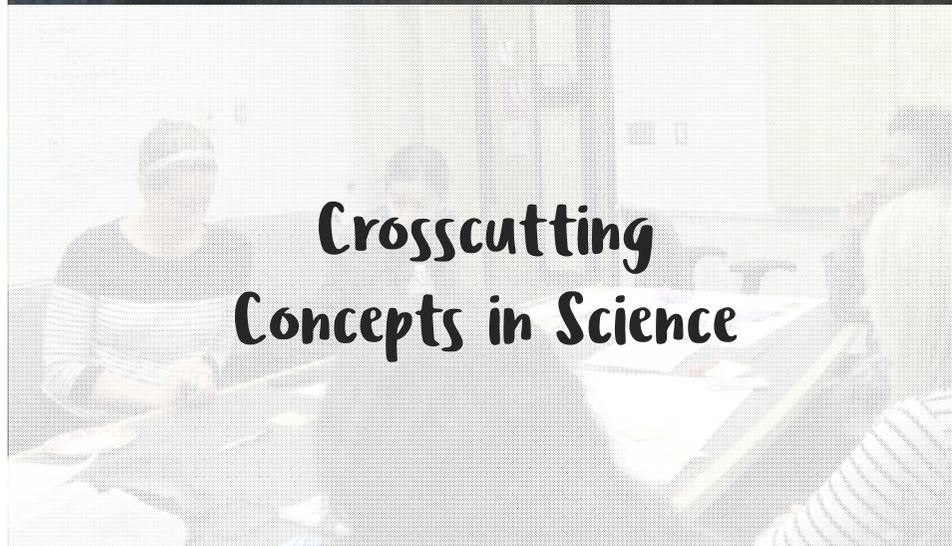
A formative design activity with experienced teachers to develop practical learning experiences

20 elementary school teachers

3 separate sessions, 2.5 hours



## Scientific Inquiry Activity



## Crosscutting Concepts in Science



## The Form and Function of Human Body

# Design Process

Ideation & Mockup

Pilot Study

Participatory Design

Three Prototypes

# Design Process

Ideation & Mockup

Pilot Study

Participatory Design

Three Prototypes

DESIGN PROCESS

# Pilot Study - Testing Technology



DESIGN PROCESS

# Pilot Study – Developing Learning Activities



# Design Process

Ideation & Mockup

Pilot Study

Participatory Design

Three Prototypes

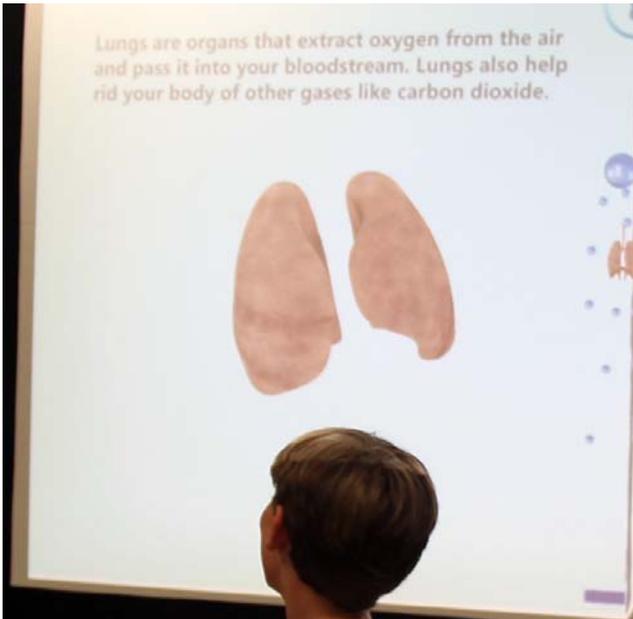
# Design Process

Ideation & Mockup

Pilot Study

Participatory Design

Three Prototypes



PROTOTYPE #1  
**Magic Mirror**

PROTOTYPE #2  
**Moving Graphs**

PROTOTYPE #3  
**Animal Avatar**

Lungs are organs that extract oxygen from the air and pass it into your bloodstream. Lungs also help rid your body of other gases like carbon dioxide.



PROTOTYPE #1

# Magic Mirror

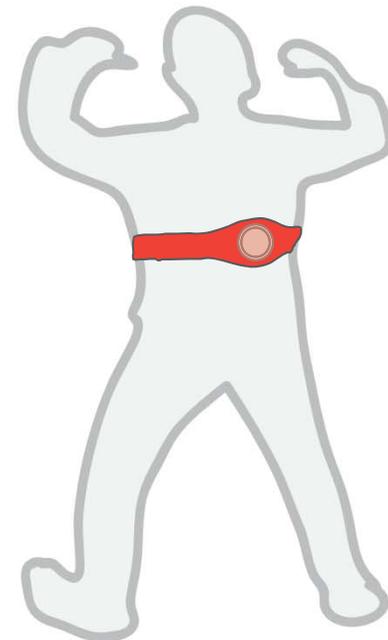


PROTOTYPE #1: MAGIC MIRROR

# Design Goals

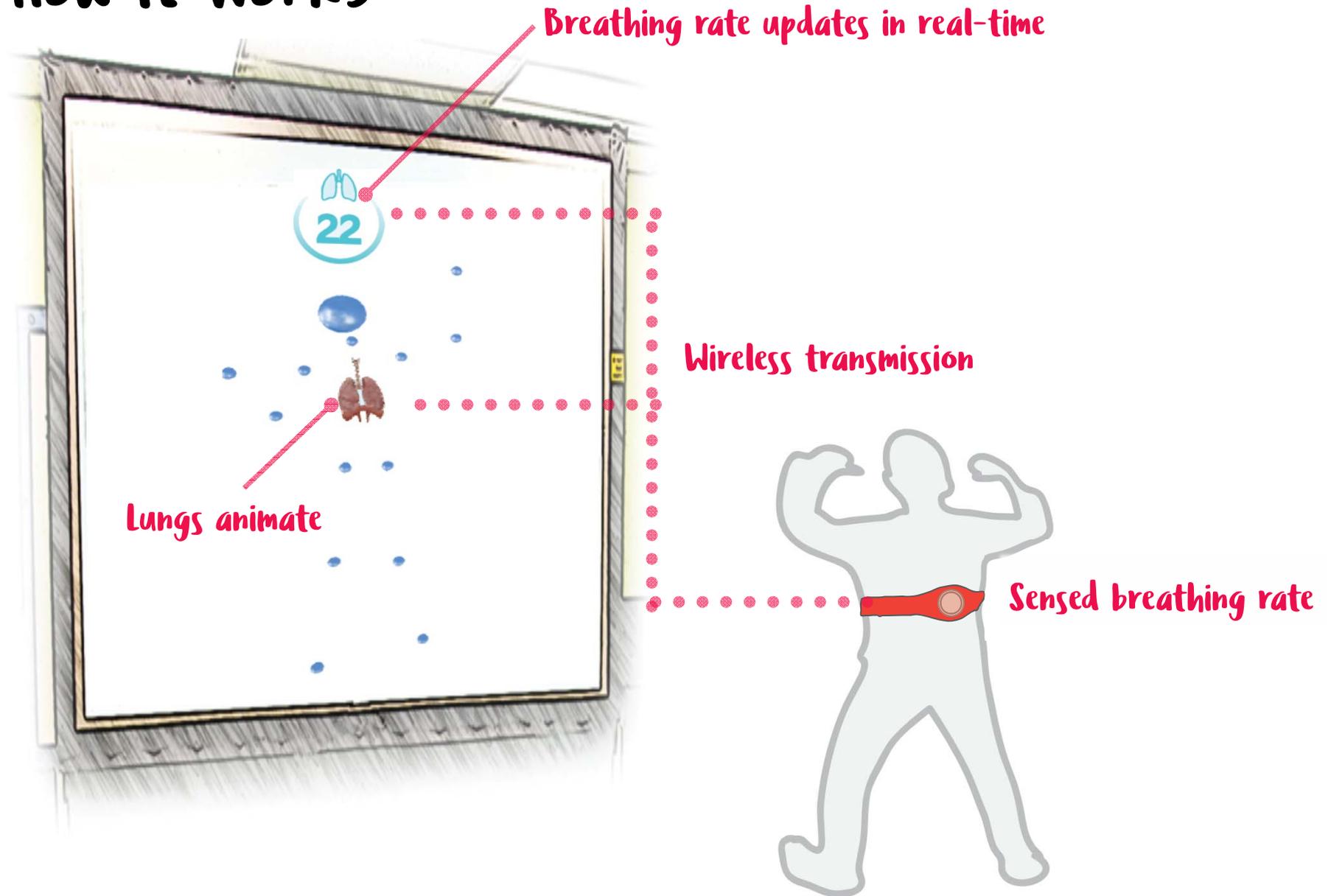


- Mirror paradigm
- Peer inside live body
- Whole-body interaction

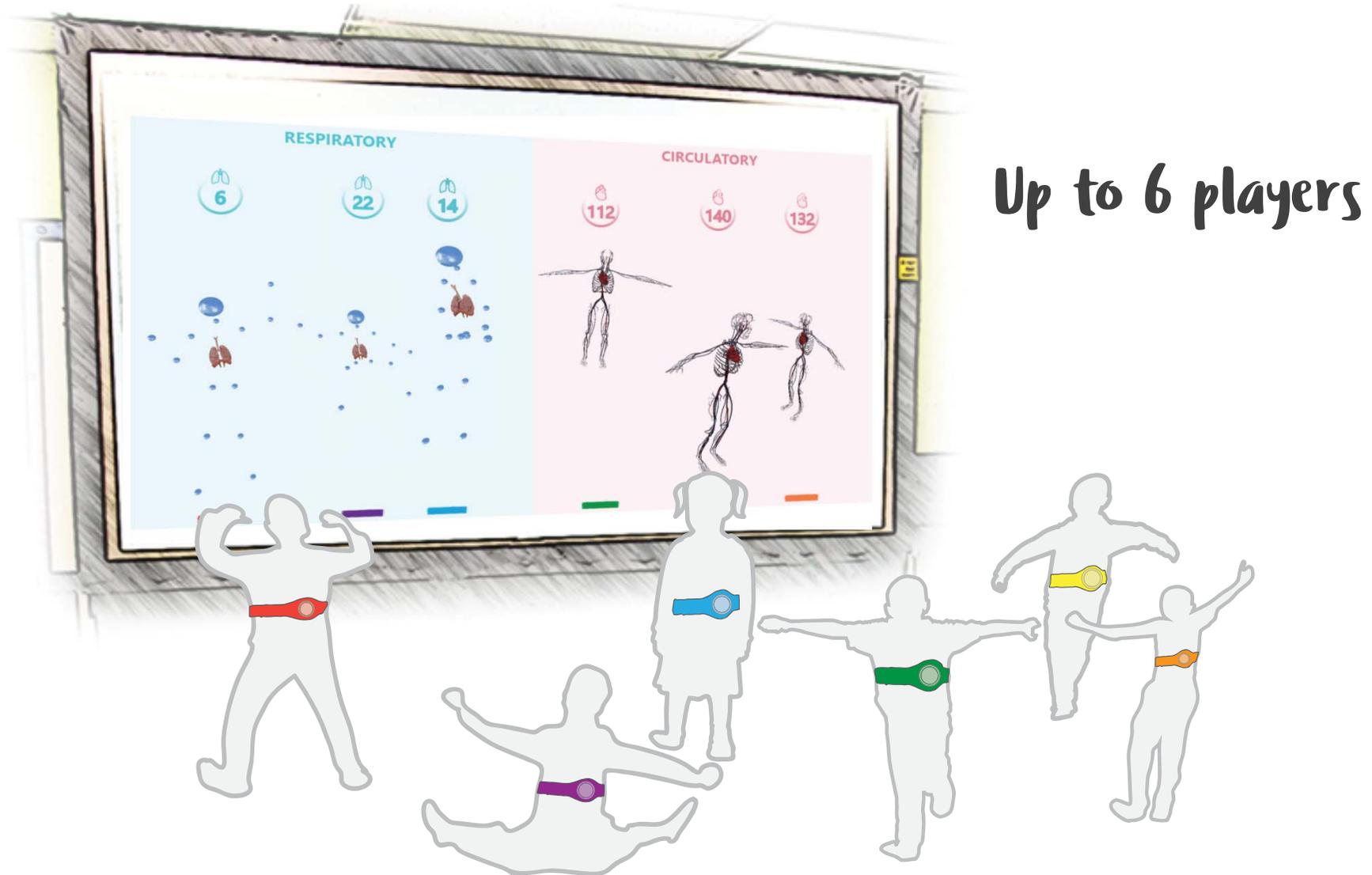


PROTOTYPE #1: MAGIC MIRROR

# How It Works



PROTOTYPE #1: MAGIC MIRROR  
**How It Works**



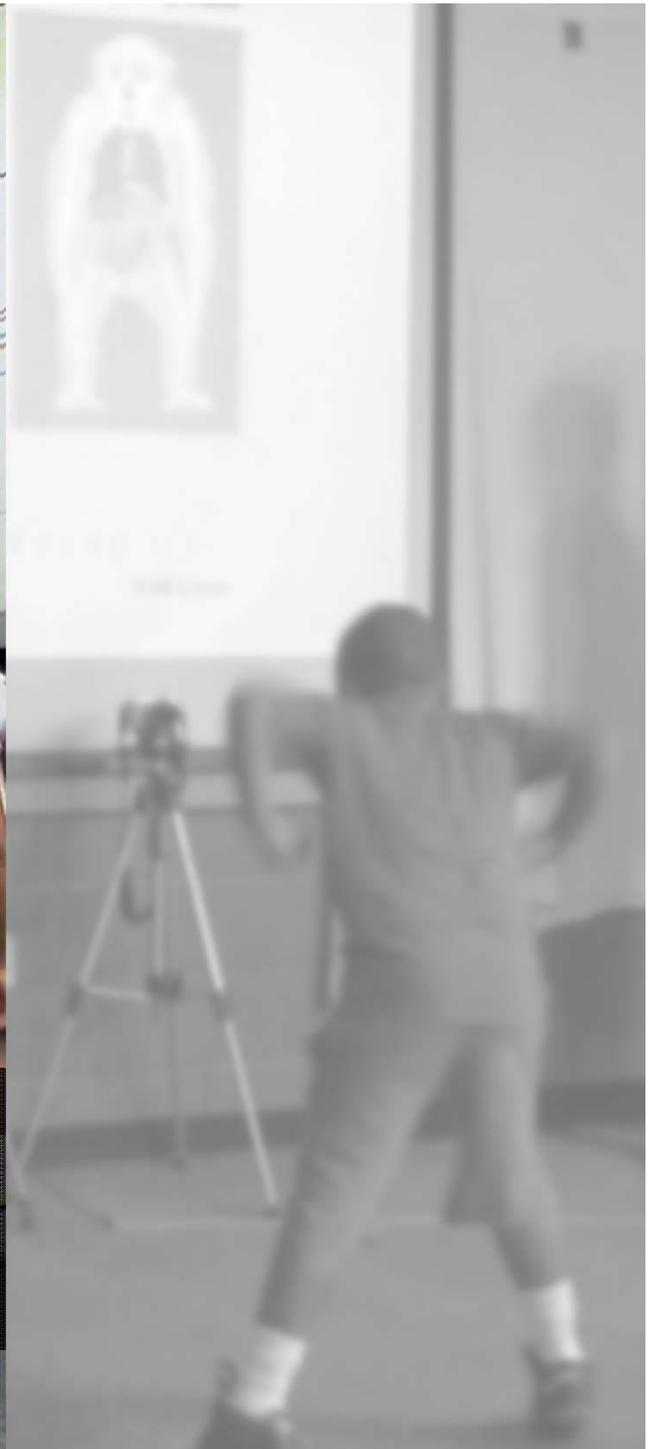
Lungs are organs that extract oxygen from the air and pass it into your bloodstream. Lungs also help rid your body of other gases like carbon dioxide.



PROTOTYPE #1

# Magic Mirror





PROTOTYPE #2: MOVING GRAPHS

# Design Goals

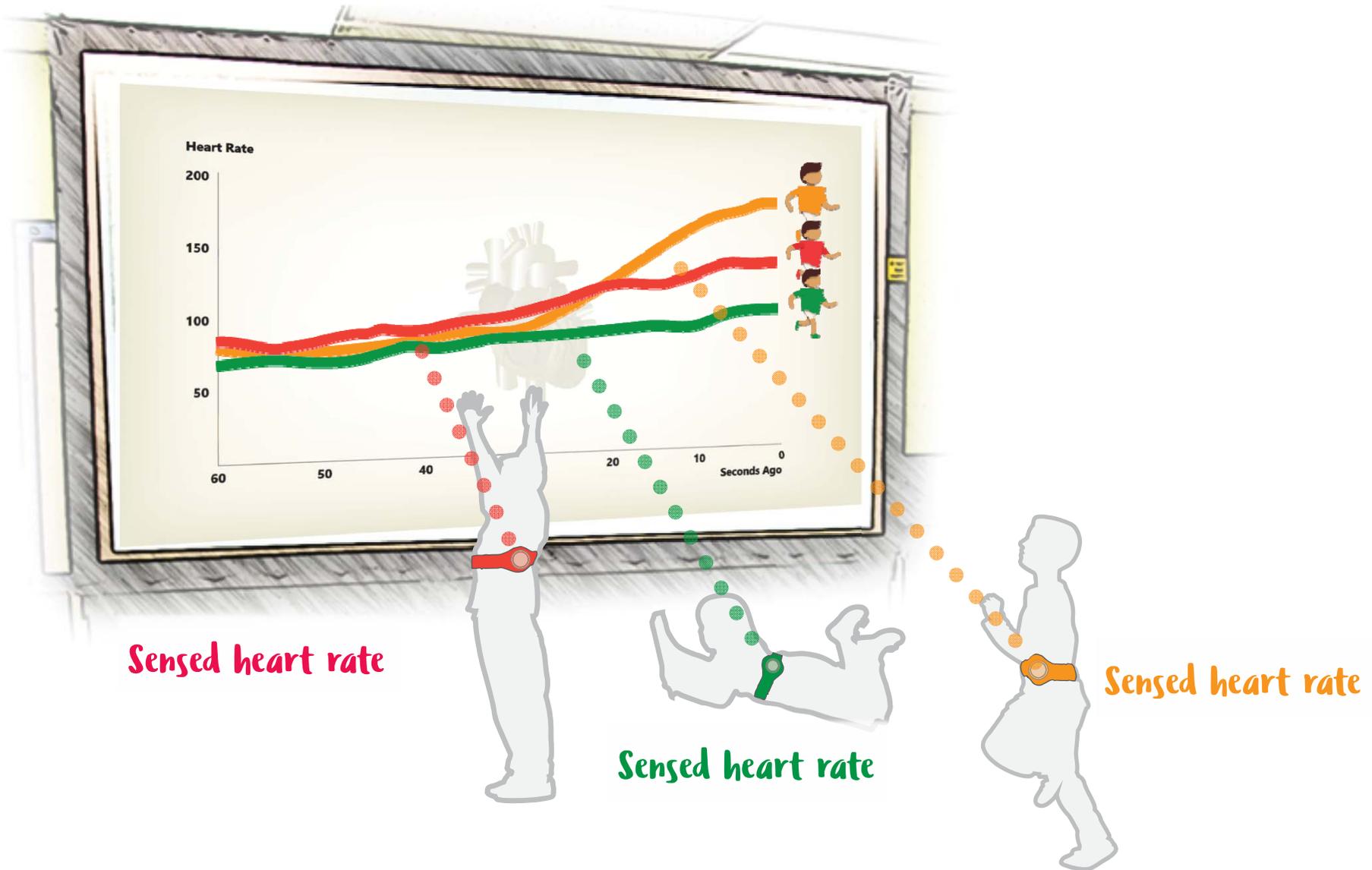


- Social comparison
- Hypothesis testing
- Basic statistics



PROTOTYPE #2: MOVING GRAPHS

# How It Works

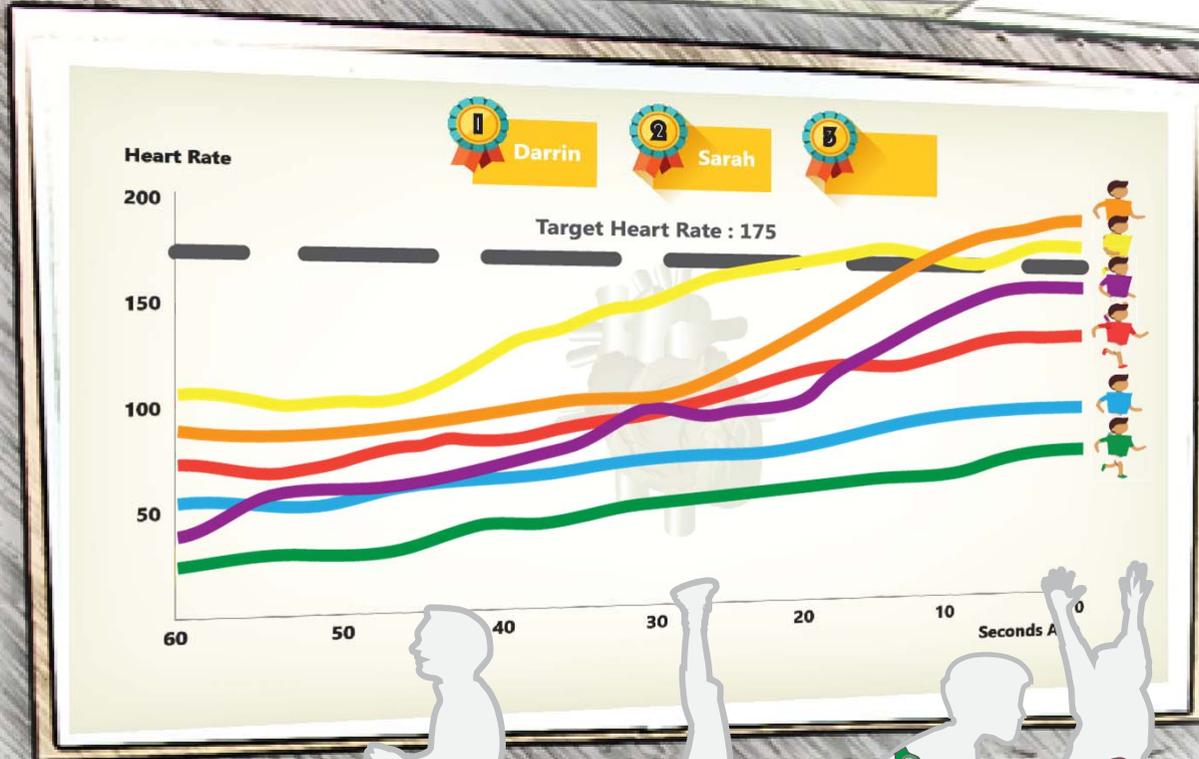


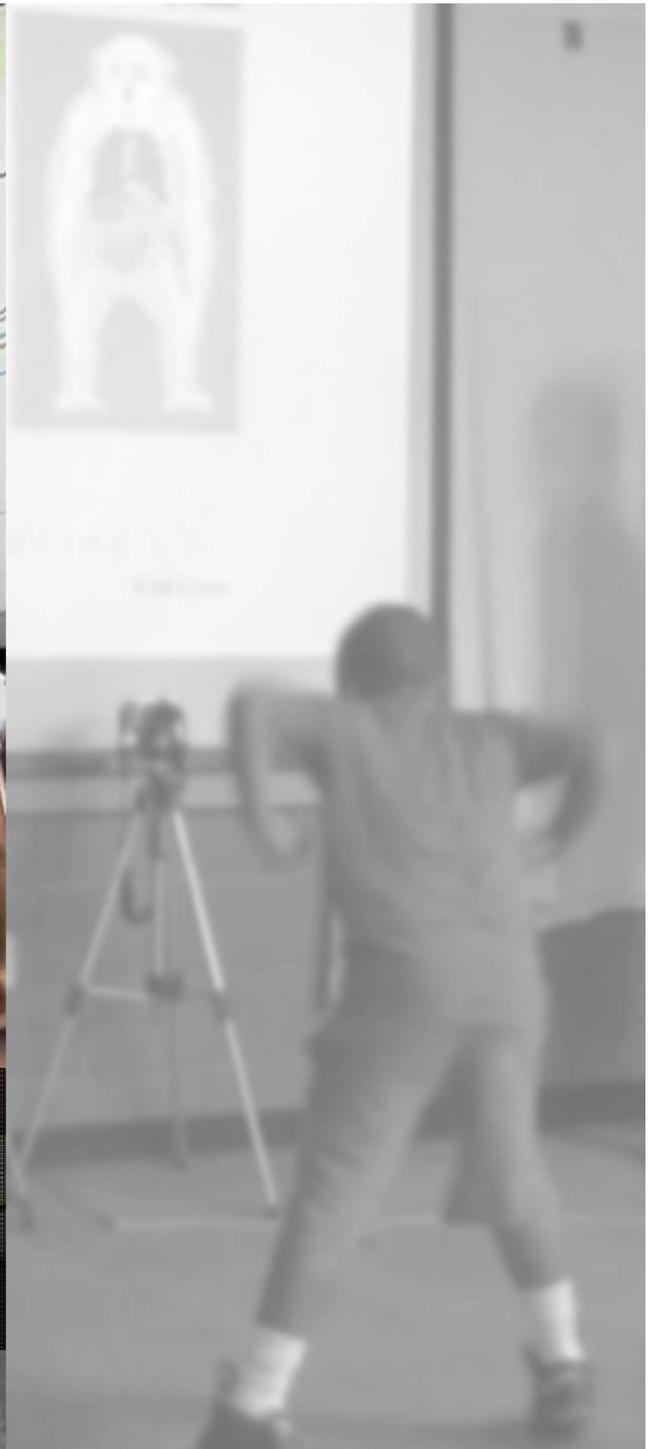
# Hypothesis Generation



PROTOTYPE #2: MOVING GRAPHS

# Hypothesis Testing





PROTOTYPE #2  
Moving Graphs

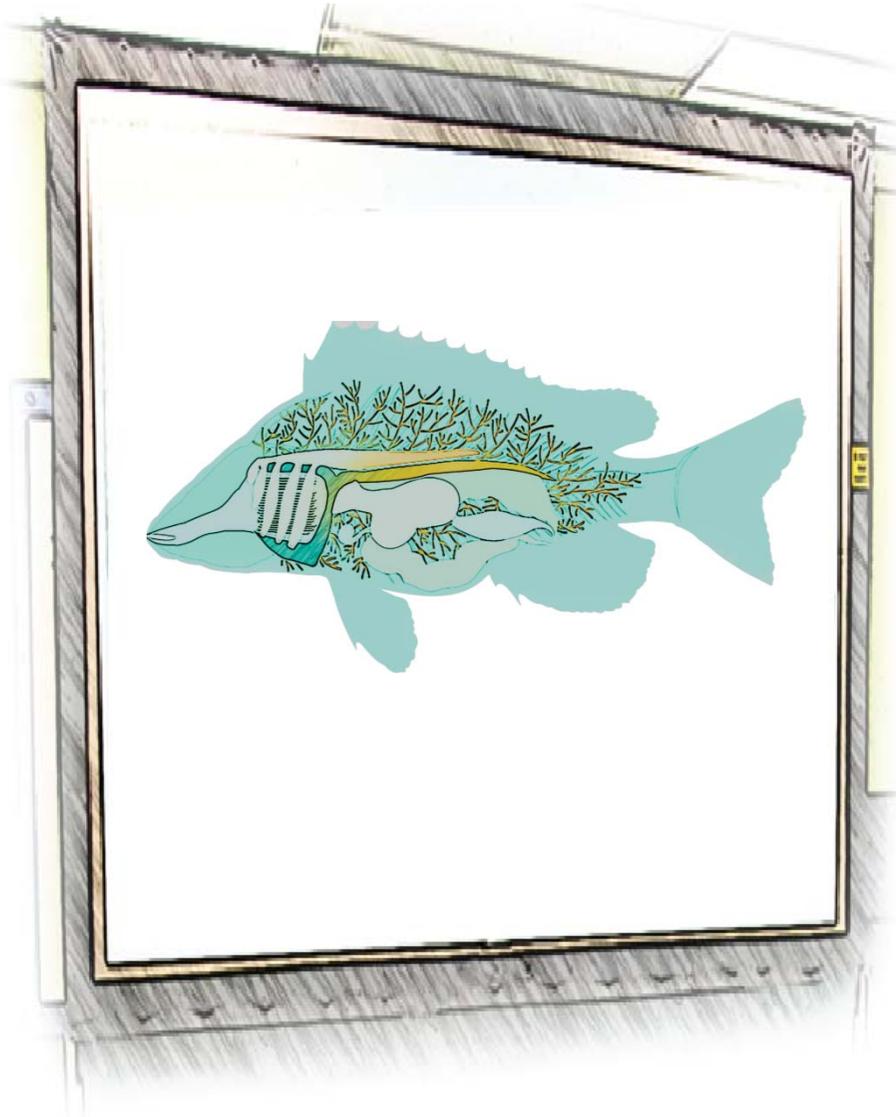


PROTOTYPE #3

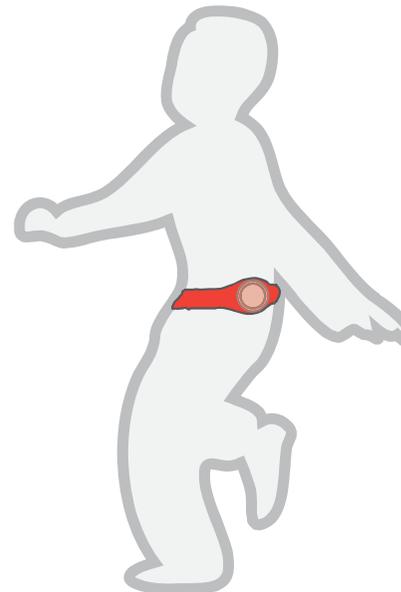
Animal Avatar

PROTOTYPE #3: ANIMAL AVATAR

# Design Goals

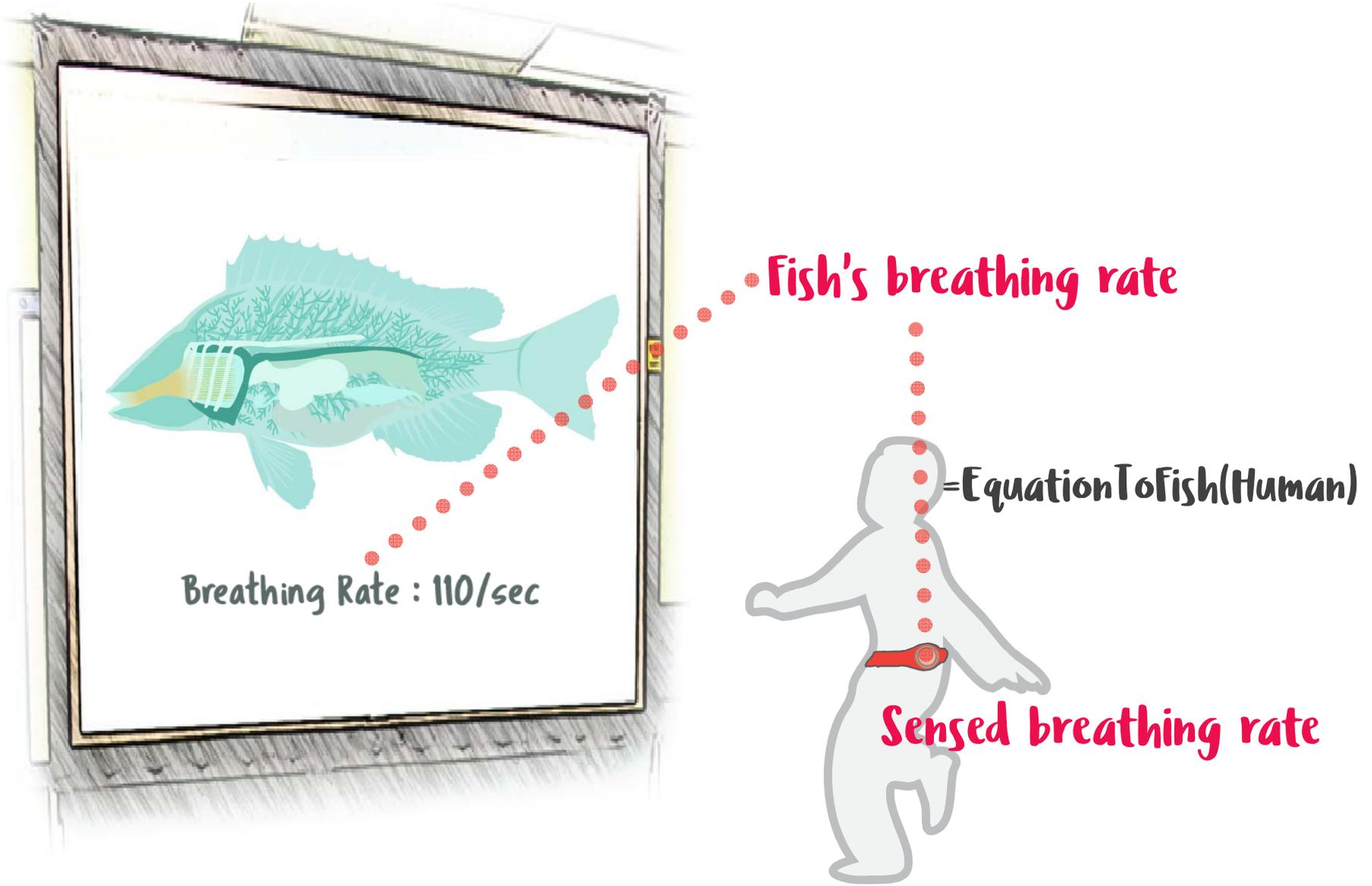


- Observation & Discovery
- Comparison & Contrast
- Cross-species Biology



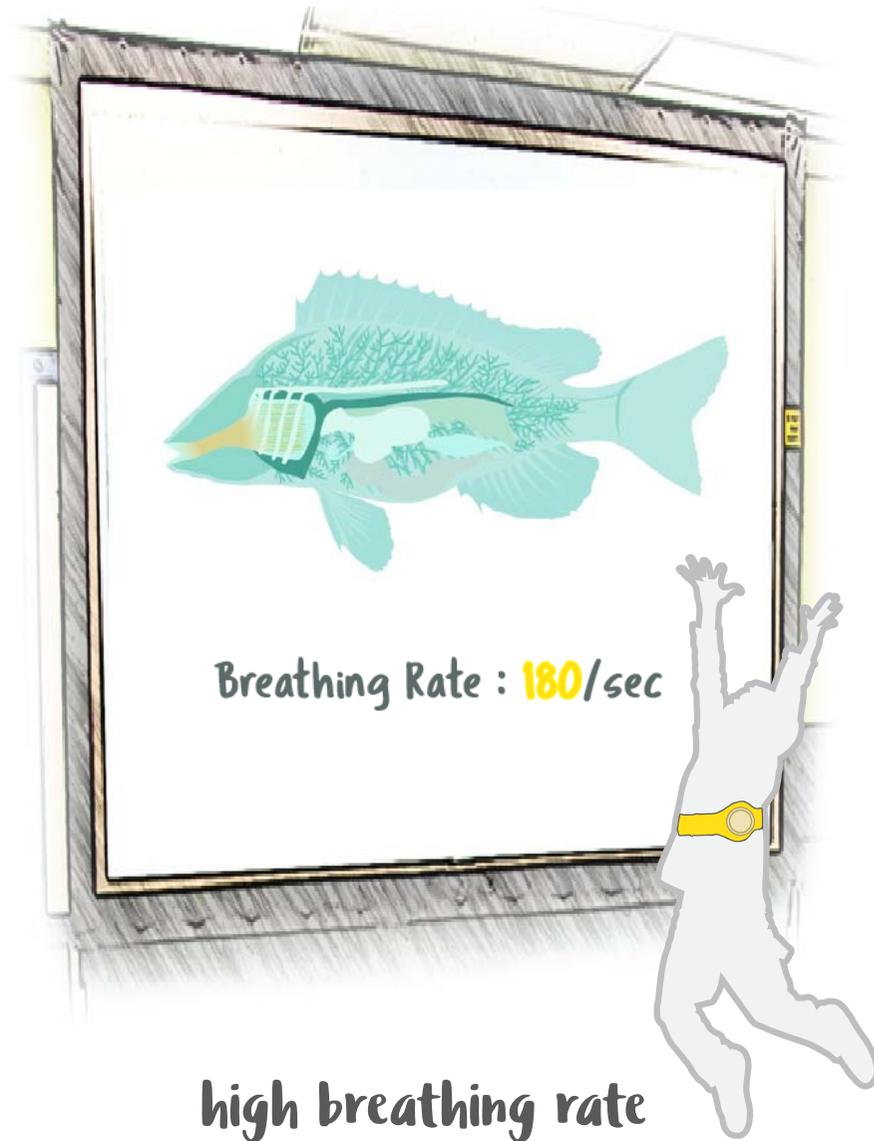
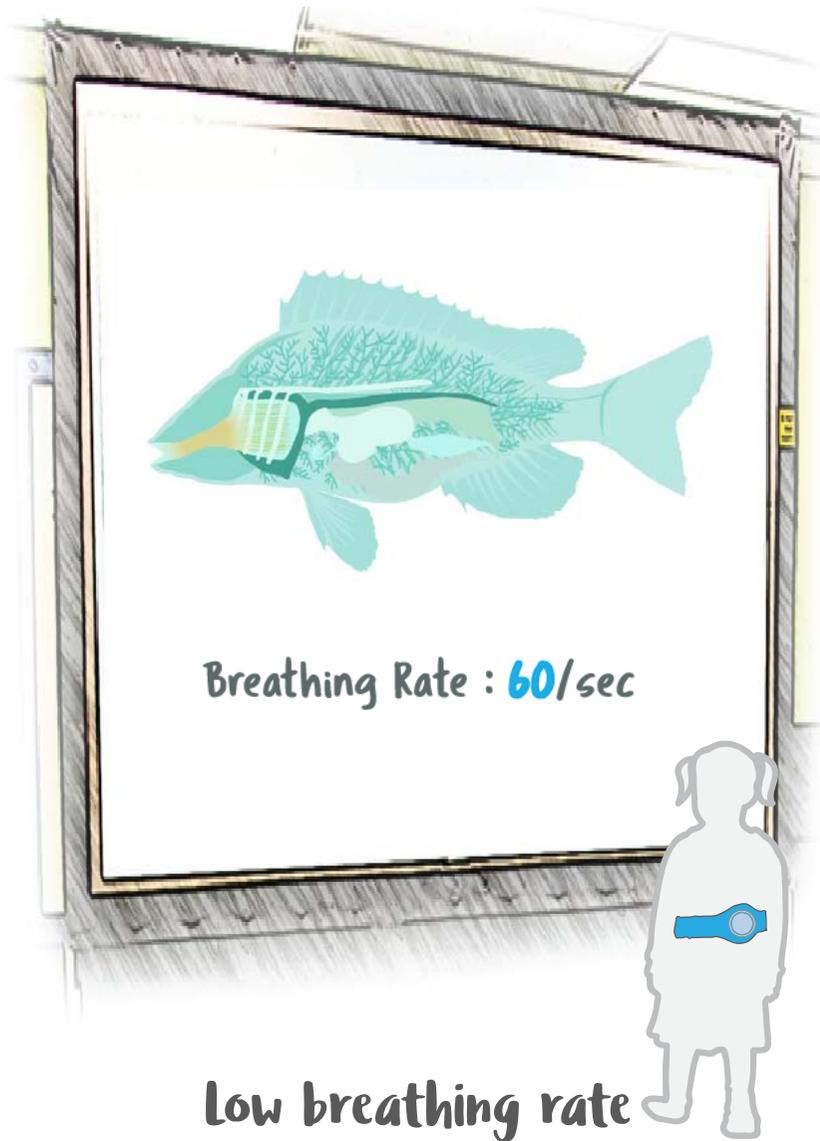
PROTOTYPE #3: ANIMAL AVATAR

# How It Works



PROTOTYPE #3: ANIMAL AVATAR

# How It Works



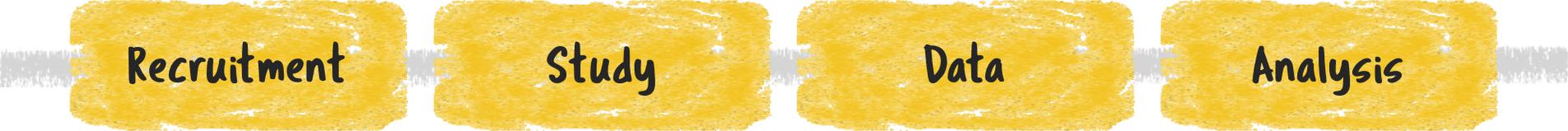
PROTOTYPE #3: ANIMAL AVATAR

# Discovering Similarity and Difference

The diagram illustrates the concept of similarity and difference between human and elephant anatomy. It is presented on a screen with a wooden frame. On the left side of the screen, under the heading "Sarah", is a human torso illustration with 14 internal organs highlighted in red. Below this illustration is a circular icon containing a pair of lungs and the number "14". On the right side of the screen, under the heading "Sarah as a elephant", is an elephant illustration with 6 internal organs highlighted in red. Below this illustration is a circular icon containing a pair of lungs and the number "6". A grey silhouette of a person wearing an orange watch stands to the right of the screen, looking at the comparison.

# Evaluation

Qualitative exploration and soliciting feedback



Recruitment

Study

Data

Analysis

# EVALUATION

## Recruitment



**SharedPhys**

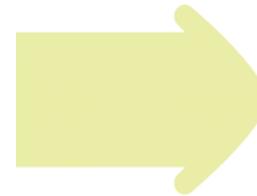
- ✓ **LIVE LEARNING**  
We support vivid, exciting, and informative learning experience combining wearable technology and learning activity
- ✓ **BODY&SCIENCE**  
We envision educational approach for learning about human body and physiology, and for supporting scientific inquiry skills
- ✓ **TECHNOLOGY**  
We explore opportunities for using information technology to support future learning.

Funky and interactive t-shirt will help children to understand their anatomy

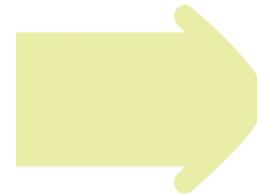
Children's live physiological data displays on large screen. Children will learn physiology, graphs, and analytics.

Realistic 3D body reacts to children's movement as well as physiology. They can learn body systems in playful way.

UNIVERSITY OF MARYLAND



Two after-school programs



# EVALUATION

## Recruitment

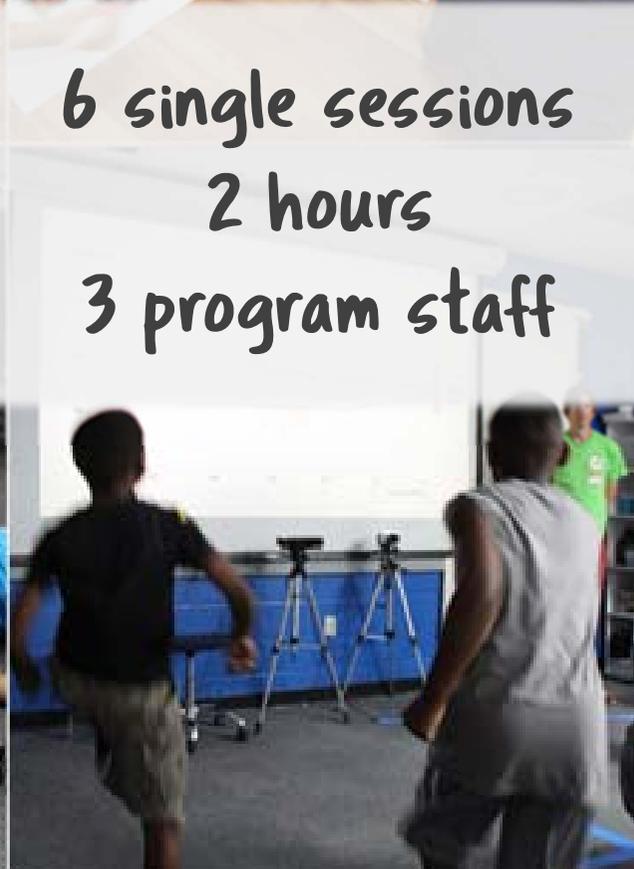


69 children participated  
aged 5~13

EVALUATION

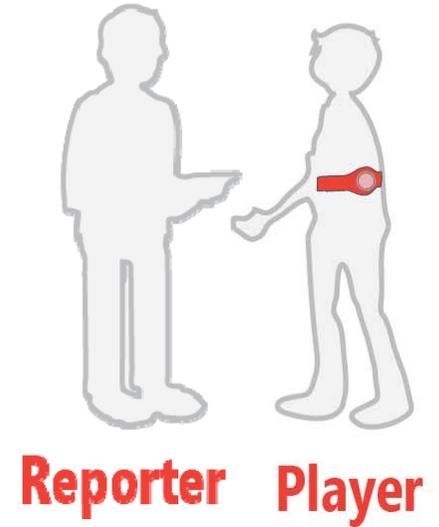
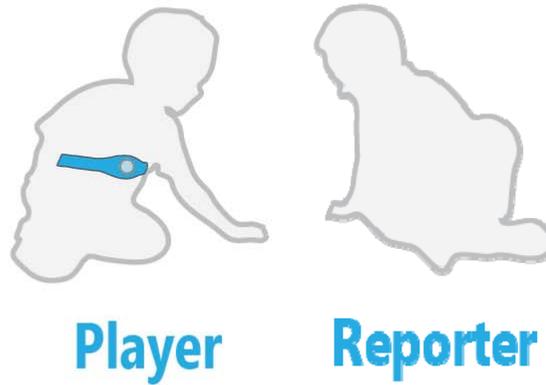
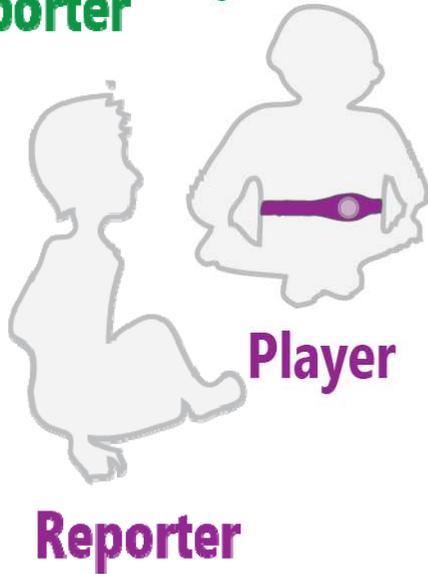
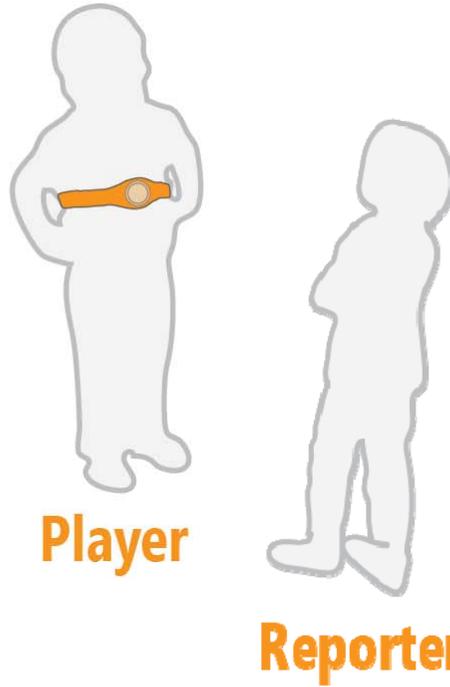
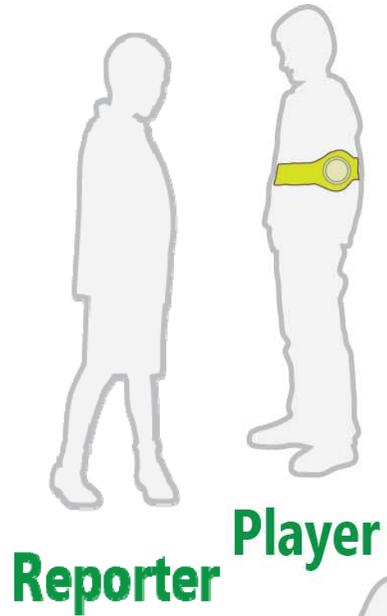
Study

6 single sessions  
2 hours  
3 program staff



Players wear sensors

Reporters do NOT



# EVALUATION

## Data



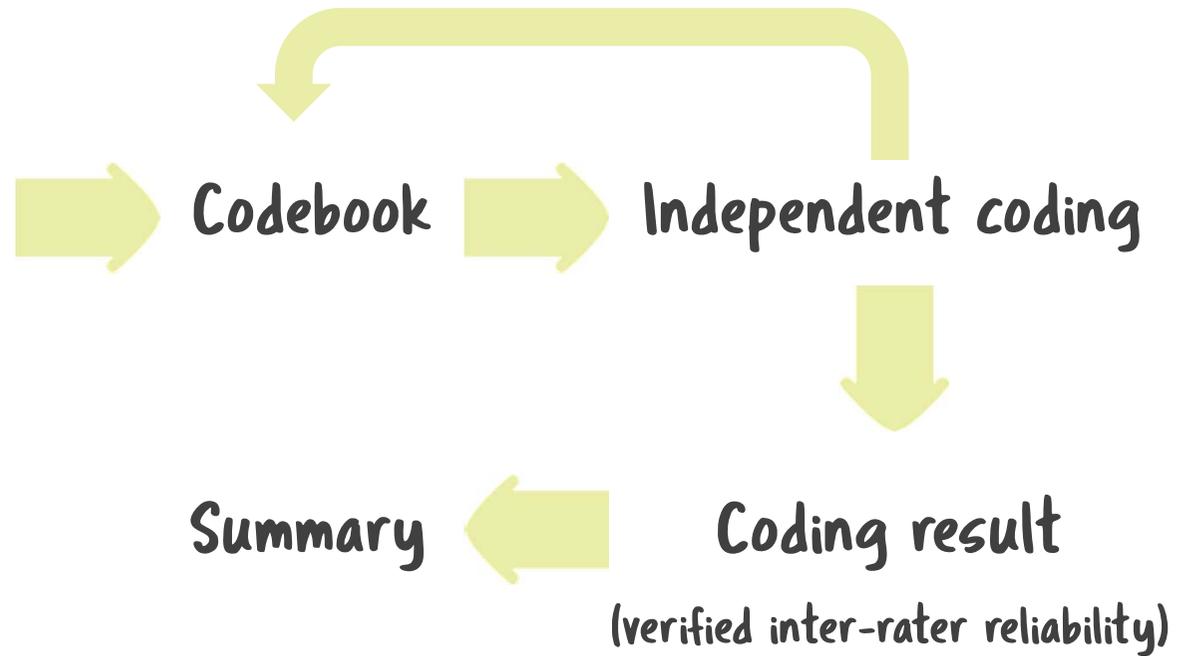
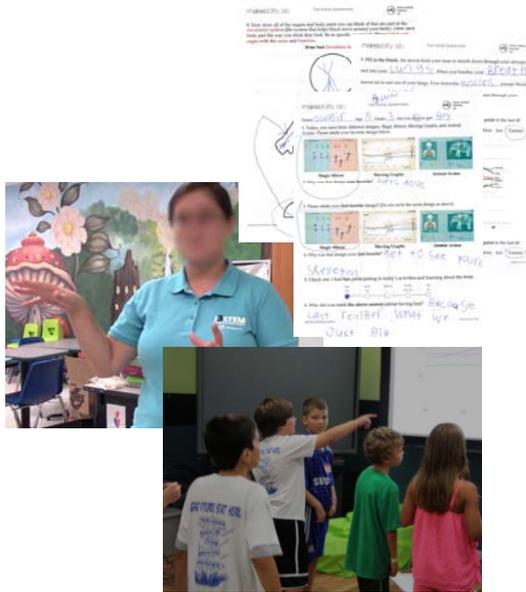
Pre&post-activity questionnaires

Video recordings

Program staff interview

# EVALUATION

Analysis



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

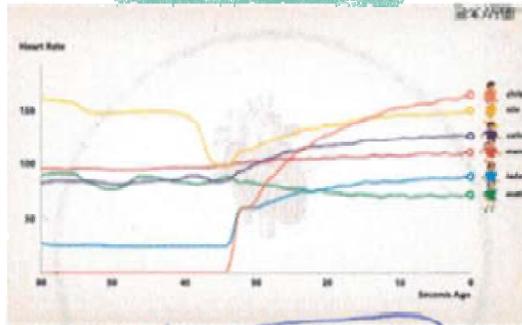
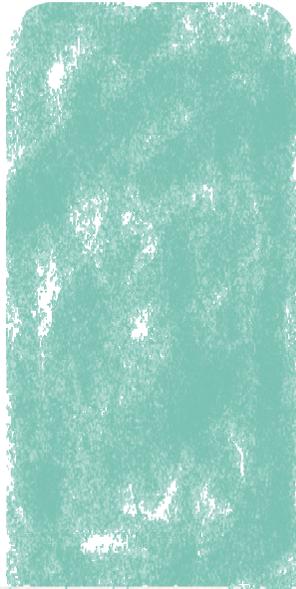
Learning  
Potential

Program Staff  
Feedback

Social  
Interactions

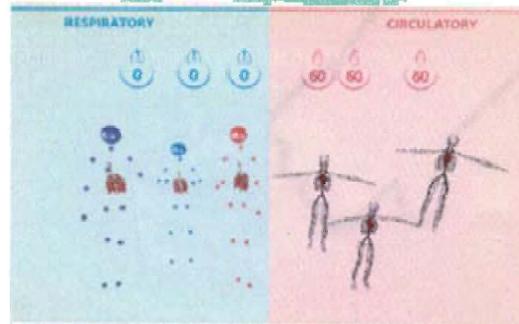
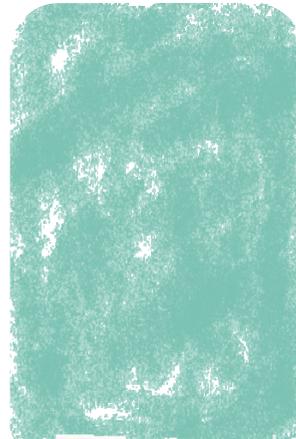
# Design Preference

41%



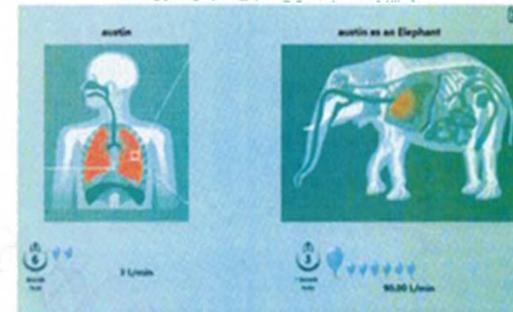
Moving Graphs

35%



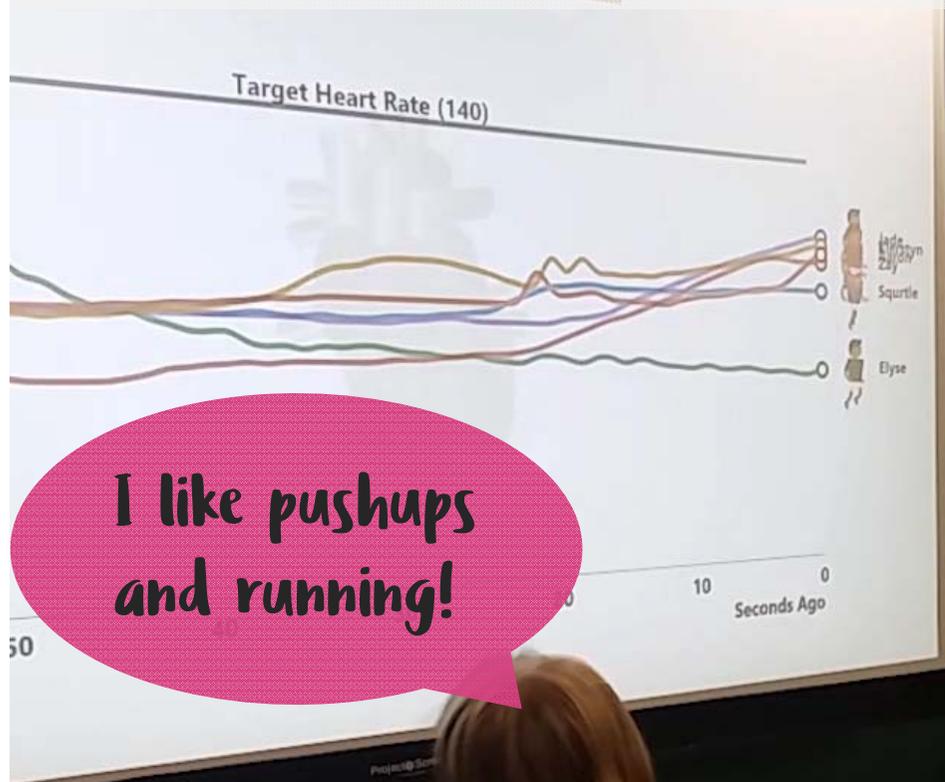
Magic Mirror

24%



Animal Avatar

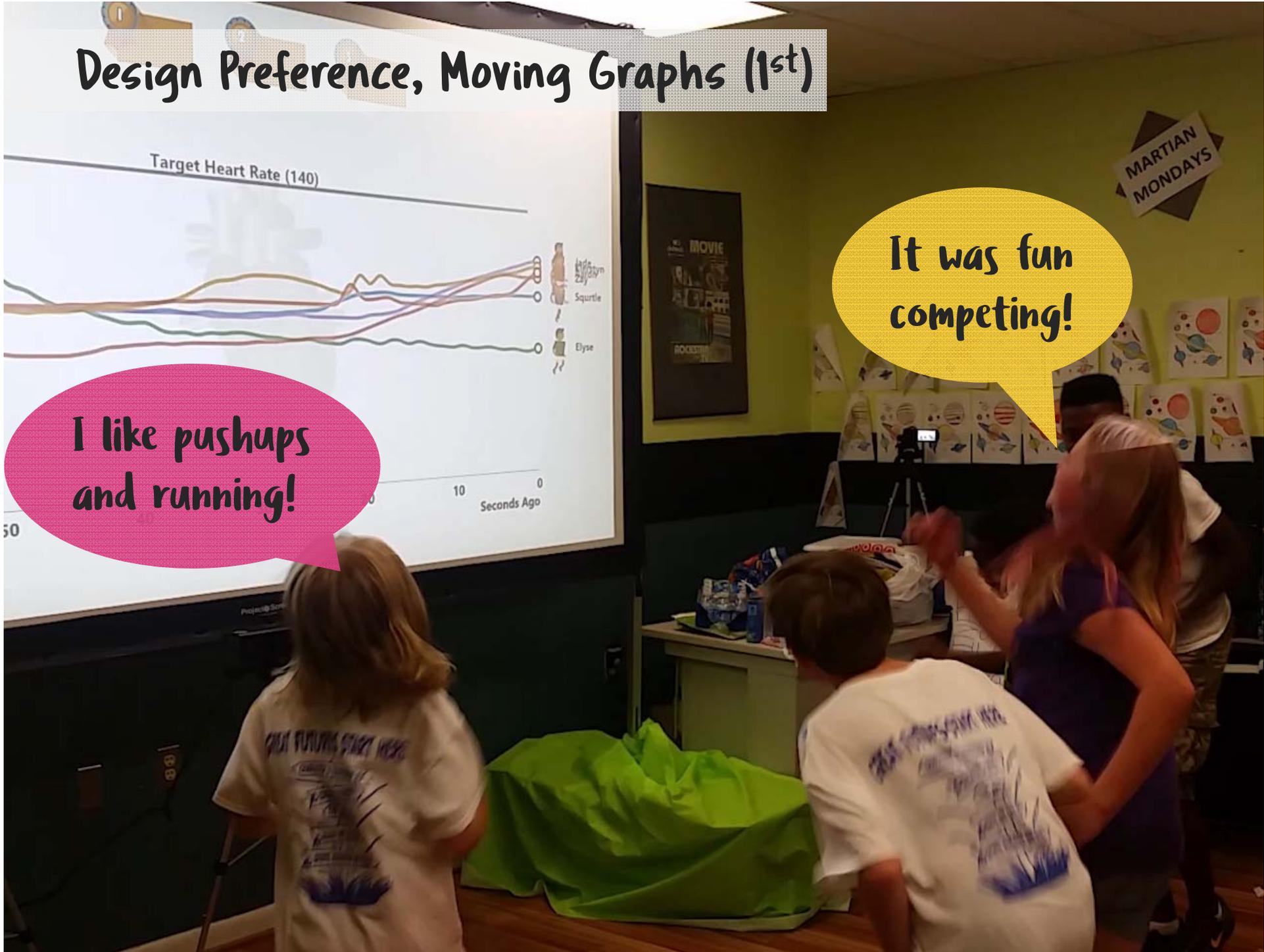
# Design Preference, Moving Graphs (1st)



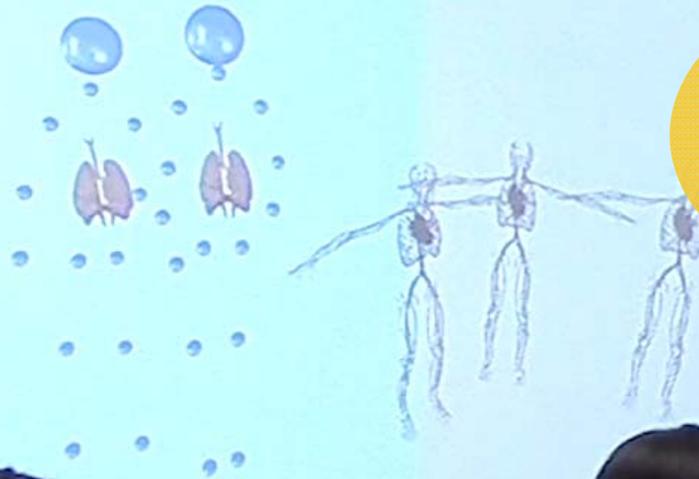
I like pushups and running!

It was fun competing!

MARTIAN MONDAYS



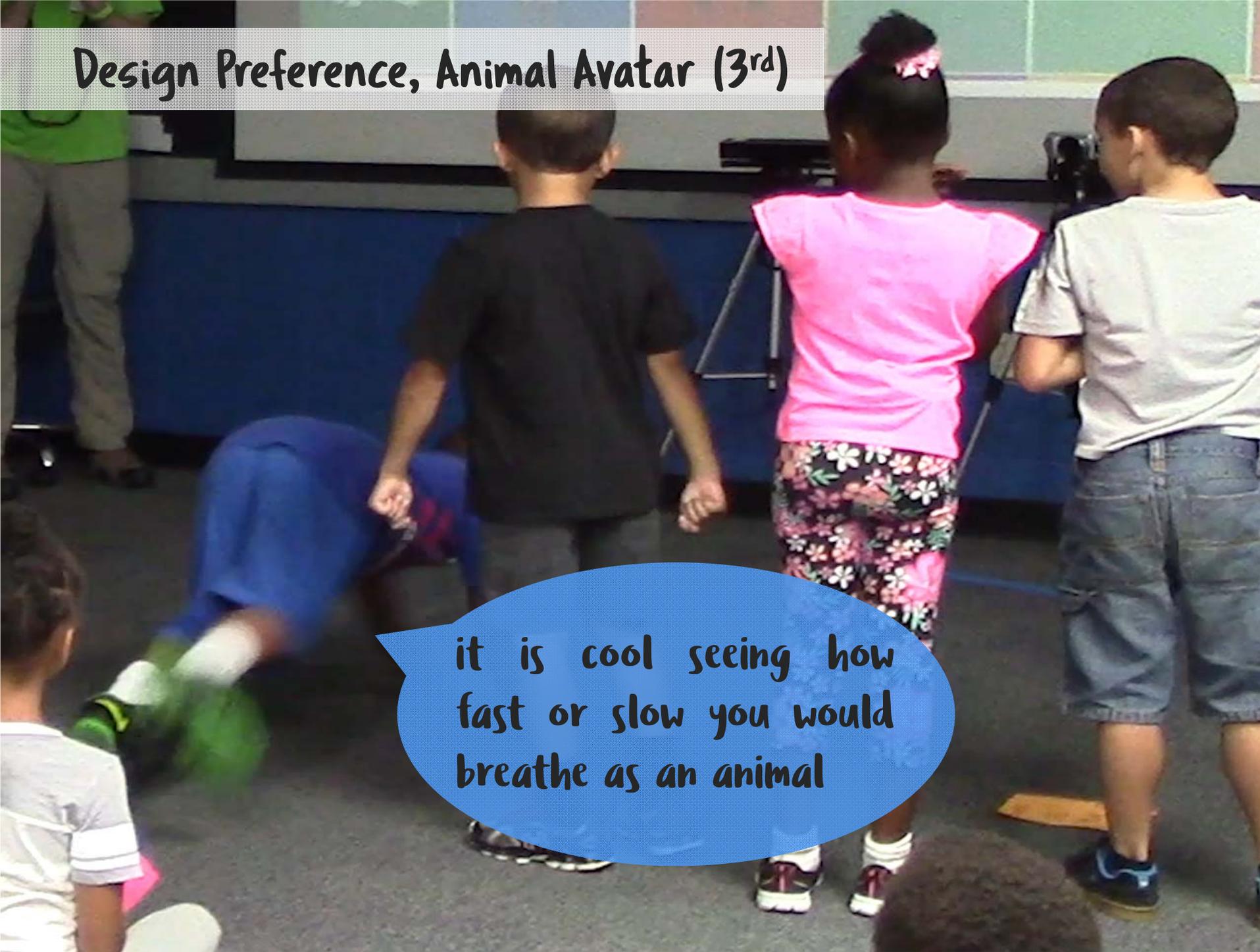
## Design Preference, Magic Mirror (2<sup>st</sup>)



I loved how it copied me!

It shows what the inside of your body looks like and how it moves

## Design Preference, Animal Avatar (3<sup>rd</sup>)



it is cool seeing how fast or slow you would breathe as an animal

# Design Preference

41%

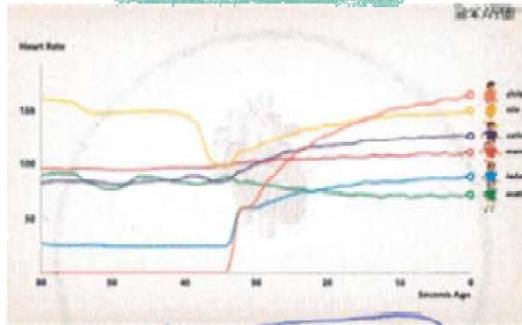


Children prefer designs with higher physical activity

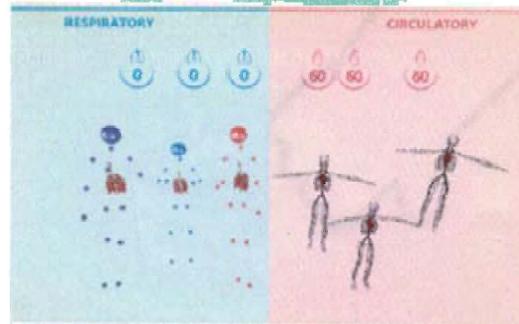
35%



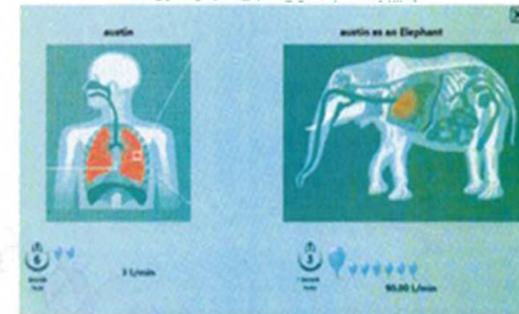
24%



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

Lucas, you're the lungs!

RESPIRATORY

### SQURTLEs lungs

Lungs are organs that extract oxygen from the air and pass it into your bloodstream. Lungs also help rid your body of other gases like carbon dioxide.



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

Enjoyment

Physical  
Interactions

Learning  
Potential

Program Staff  
Feedback

Social  
Interactions

# Learning Potential

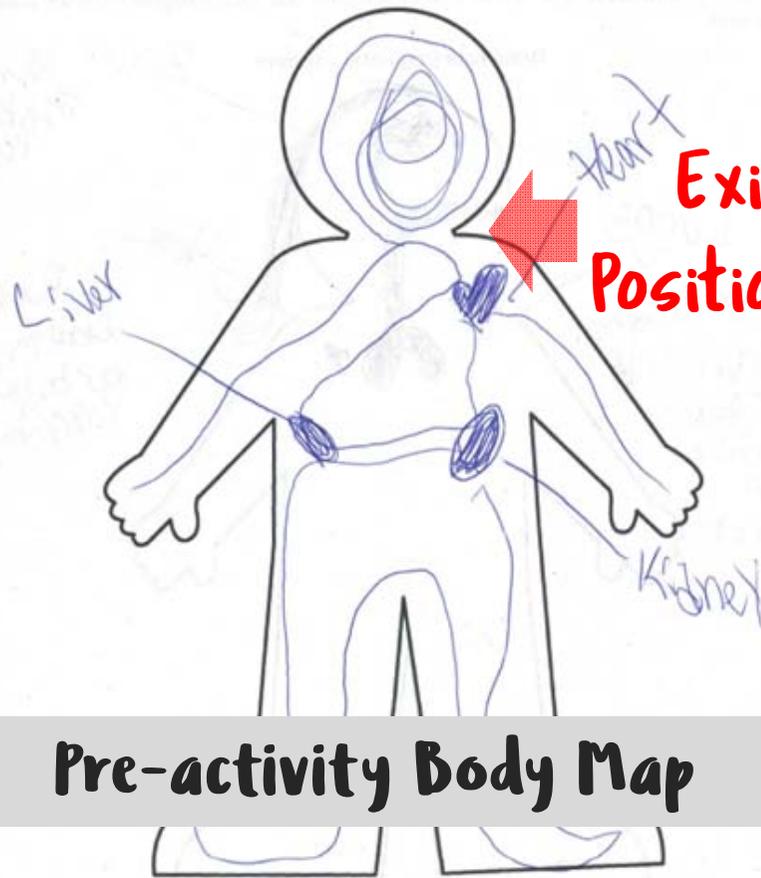
makeability lab

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**



Pre-activity Body Map

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**



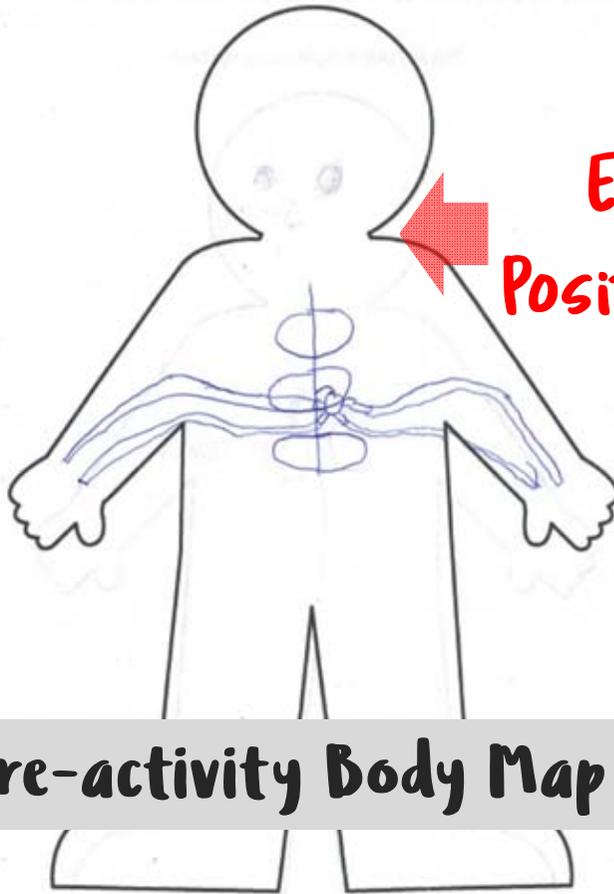
Post-activity Body Map

Existence & Position Examined

# Learning Potential

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**.

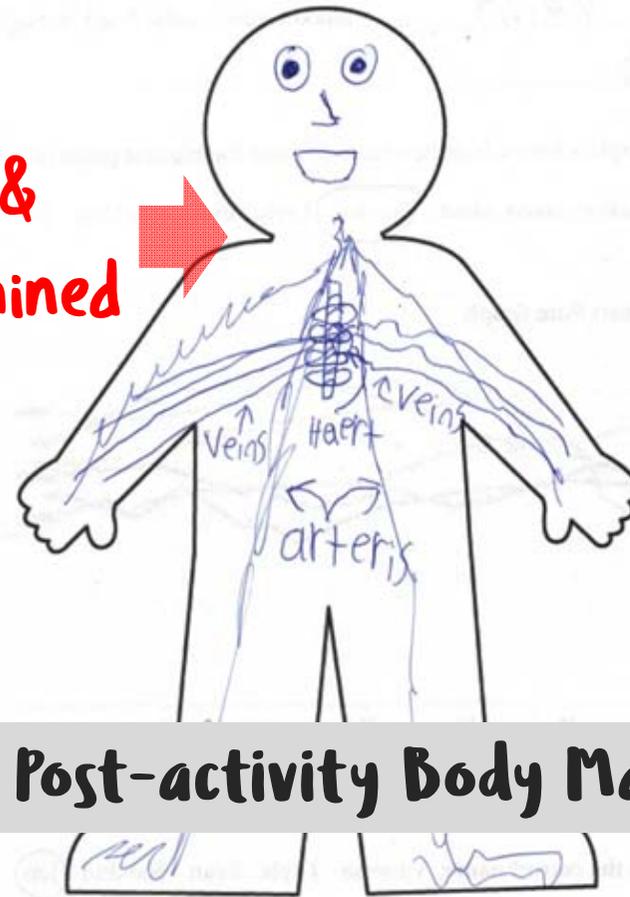
Draw Your **Circulatory System**



Pre-activity Body Map

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**.

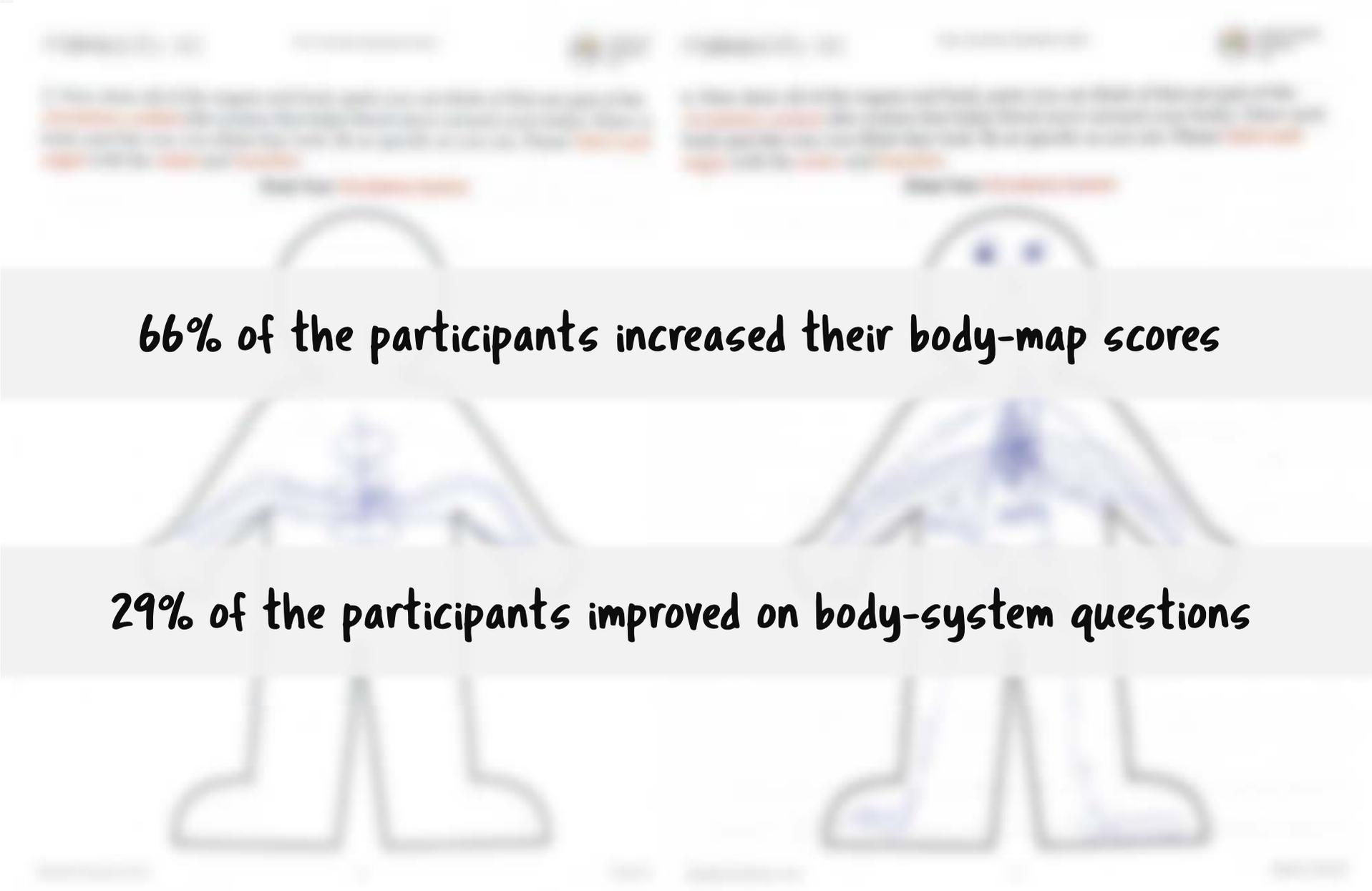
Draw Your **Circulatory System**



Post-activity Body Map

Existence & Position Examined

# 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

Program Staff  
Feedback

Social  
Interactions



# Program staff feedback

was very authentic... it just really made the math alive

Authentic connection between body data and visualization

**i3STEM**  
Imagine. Invent. Inspire.

# Program staff feedback

it's one thing to show a picture of the respiratory system, it's another thing to have them see their own

The importance of physicality and mimicry

## Program staff feedback

the cause and effect relationship,  
the interactivity...All those things  
make much more personal education

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**

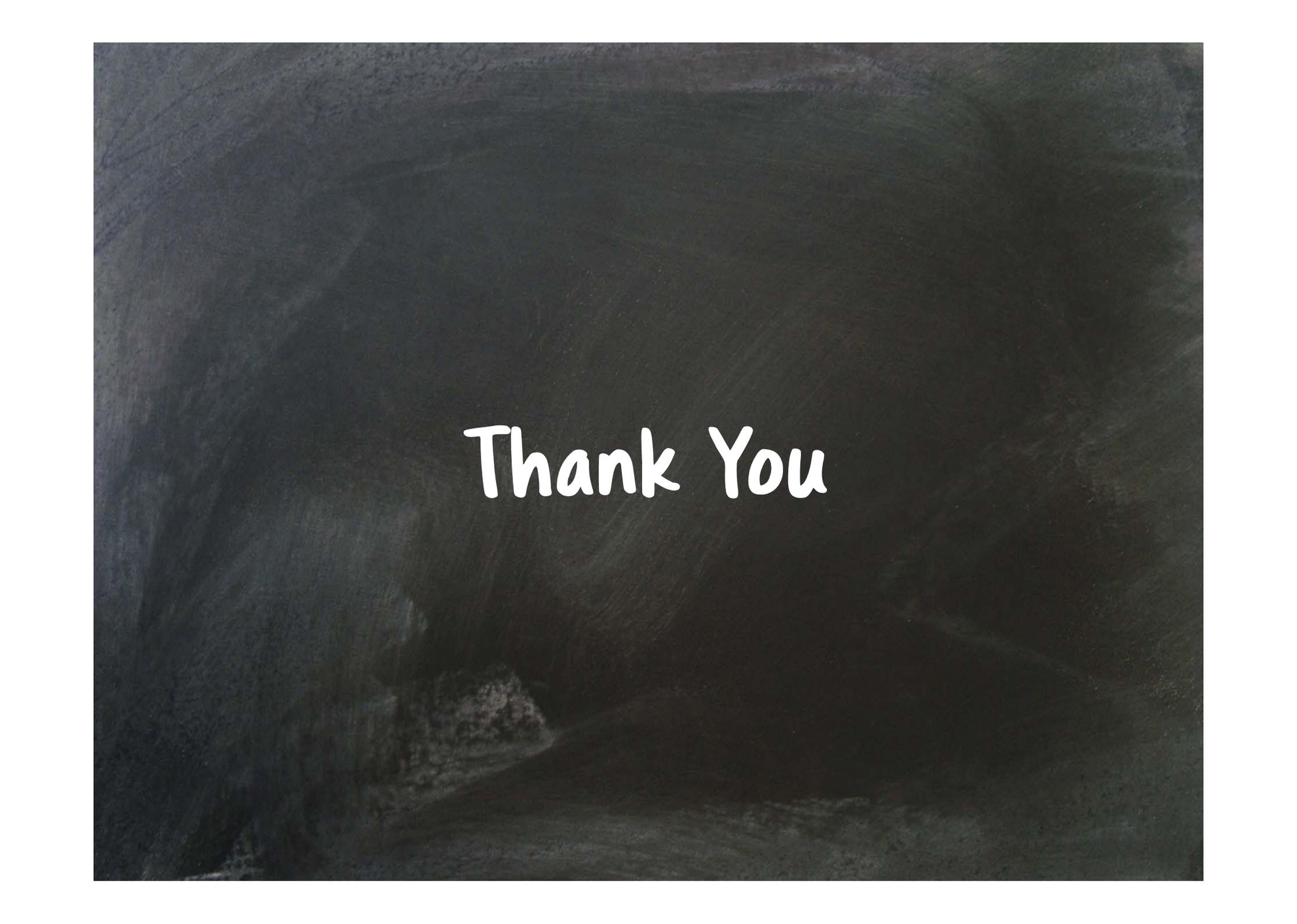
# Summary

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

The image features a dark, almost black, textured background that resembles a chalkboard or a piece of rough paper. The texture is uneven, with subtle variations in tone and some faint, lighter-colored smudges or fibers. Centered in the middle of the frame is the text "Thank You" written in a clean, white, sans-serif font. The letters are sharp and stand out prominently against the dark background.

Thank You