**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
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

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

- Ideation & Mockup
- Participatory Design
- Pilot Study
- Three Prototypes

Children

Teachers
Design Process

- Ideation & Mockup
- Pilot Study
- Participatory Design
- Three Prototypes
### Heart Rate

<table>
<thead>
<tr>
<th></th>
<th>Bob</th>
<th>Lily</th>
<th>Adam</th>
<th>Tim</th>
<th>Jill</th>
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<tbody>
<tr>
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<td>141</td>
<td>134</td>
<td>130</td>
<td>100</td>
<td>95</td>
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<tr>
<td></td>
<td>Joe</td>
<td>Mike</td>
<td>Lisa</td>
<td>Chelsea</td>
<td>Sarah</td>
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**Group Averages**

- **Highest**: Bob: 141
- **Lowest**: Jill: 95
- **Average**: XXX

**Mockup Example 1**

**Social Comparison of Live Body Data**
Breathing Rate

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

Mockup Example 2
Connect With Body Learning
Design Process

- Ideation & Mockup
- Participatory Design
- Pilot Study
- Three Prototypes
Design Process

- Ideation & Mockup
- Participatory Design
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- Three Prototypes
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
- Participatory Design
- Pilot Study
- Three Prototypes
Design Process

- Ideation & Mockup
- Pilot Study
- Participatory Design
- Three Prototypes
Design Process

Pilot Study - Testing Technology
Pilot Study – Developing Learning Activities
Design Process

- Ideation & Mockup
- Pilot Study
- Participatory Design
- Three Prototypes
Design Process

- Ideation & Mockup
- Participatory Design
- Pilot Study
- 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

Design Goals

- Mirror paradigm
- Peer inside live body
- Whole-body interaction
PROTOTYPE #1: MAGIC MIRROR

How It Works

- Sensed breathing rate
- Wireless transmission
- Breathing rate updates in real-time
- Lungs animate
- Sensed breathing rate
Prototype #1: Magic Mirror

How It Works

Up to 6 players
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 #2: Moving Graphs

Design Goals

- Social comparison
- Hypothesis testing
- Basic statistics
How It Works

Sensed heart rate

Sensed heart rate

Sensed heart rate

Sensed heart rate
Prototype #2: Moving Graphs

Hypothesis Generation

Which activity makes our heart beat faster?

How can we make our heart beat slow?
Prototype #2: Moving Graphs

Hypothesis Testing
PROTOTYPE #3

Animal Avatar
Prototype #3: Animal Avatar

Design Goals

- Observation & Discovery
- Comparison & Contrast
- Cross-species Biology
PROTOTYPE #3: ANIMAL AVATAR

How It Works

Sensed breathing rate = EquationToFish(Human)

Breathing Rate: 110/sec

Fish’s breathing rate

Sensed breathing rate
Prototype #3: Animal Avatar

How It Works

Breathing Rate: 60/sec
Low breathing rate

Breathing Rate: 180/sec
High breathing rate
Prototype #3: Animal Avatar

Discovering Similarity and Difference

Sarah
Sarah as a elephant

14
6
Evaluation

Qualitative exploration and soliciting feedback
**Evaluation**

**Recruitment**

**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.

*SharedPhys*

- 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.

**Two after-school programs**
69 children participated
aged 5~13
6 single sessions
2 hours
3 program staff
Players wear sensors
Reporters do NOT
Pre&post-activity questionnaires

Video recordings

Program staff interview
Researchers independently analyzed the data, iterating on codebook
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Results

Design Preferences

Enjoyment

Physical Interactions

Learning Potential

Program Staff Feedback

Social Interactions
Design Preference

41%

35%

24%

Moving Graphs

Magic Mirror

Animal Avatar
Design Preference, Moving Graphs (1st)

It was fun competing!

I like pushups and running!
Design Preference, Magic Mirror (2st)

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

I loved how it copied me!
it is cool seeing how fast or slow you would breathe as an animal
Design Preference

Children prefer designs with higher physical activity:

- 41%
- 35%
- 24%

Choices:
- 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!

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

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

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

Existence & Position Examined

Pre-activity Body Map  Post-activity Body Map
Learning Potential

Pre-activity Body Map

Existence & Position Examined

Post-activity Body Map
Learning Potential

66% of the participants increased their body-map scores

29% of the participants improved on body-system questions
Program staff feedback:

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

Authentic connection between body data and visualization
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

Making STEM learning relevant and fun

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