

“That’s your heart!”

Live Physiological Sensing & Visualization Tools for Life-Relevant & Collaborative STEM Learning



Leyla Norooz | Tamara L. Clegg | Seokbin Kang | Angelisa C. Plane | Vanessa Oguamanam | Jon E. Froehlich



What if our clothes revealed how our body  
**functions?**

How could this **change** the way **children learn** about  
and understand their bodies?

Could a t-shirt be a **platform** for **experimentation**  
and **inquiry?**

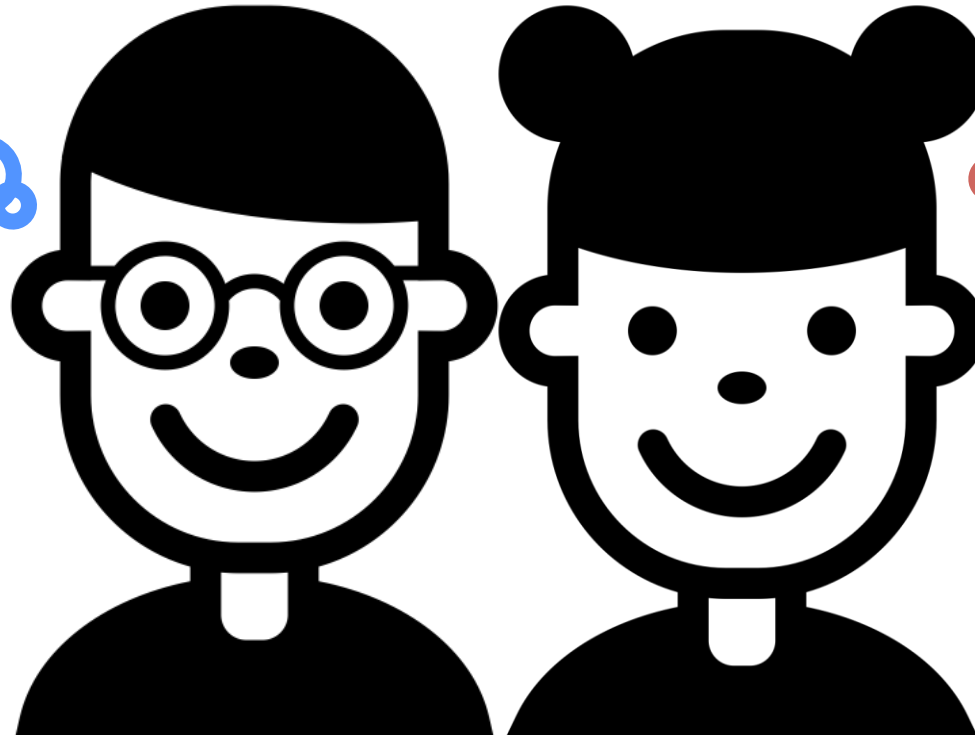
# **LIVE PHYSIOLOGICAL SENSING & VISUALIZATION**

LPSV

A young girl with long brown hair and a pink shirt is looking at a mannequin wearing a green shirt with a pink graphic. A young boy with dark hair and a blue shirt is also looking at the mannequin. The background shows a window with a view of a building and a white curtain.

How can **LPSV tools** support **life-relevant, collaborative** STEM learning experiences for youth?

# LIFE RELEVANT INQUIRY EXPERIENCES



# LIFE RELEVANT INQUIRY EXPERIENCES

Science Inquiry  
&  
Learning

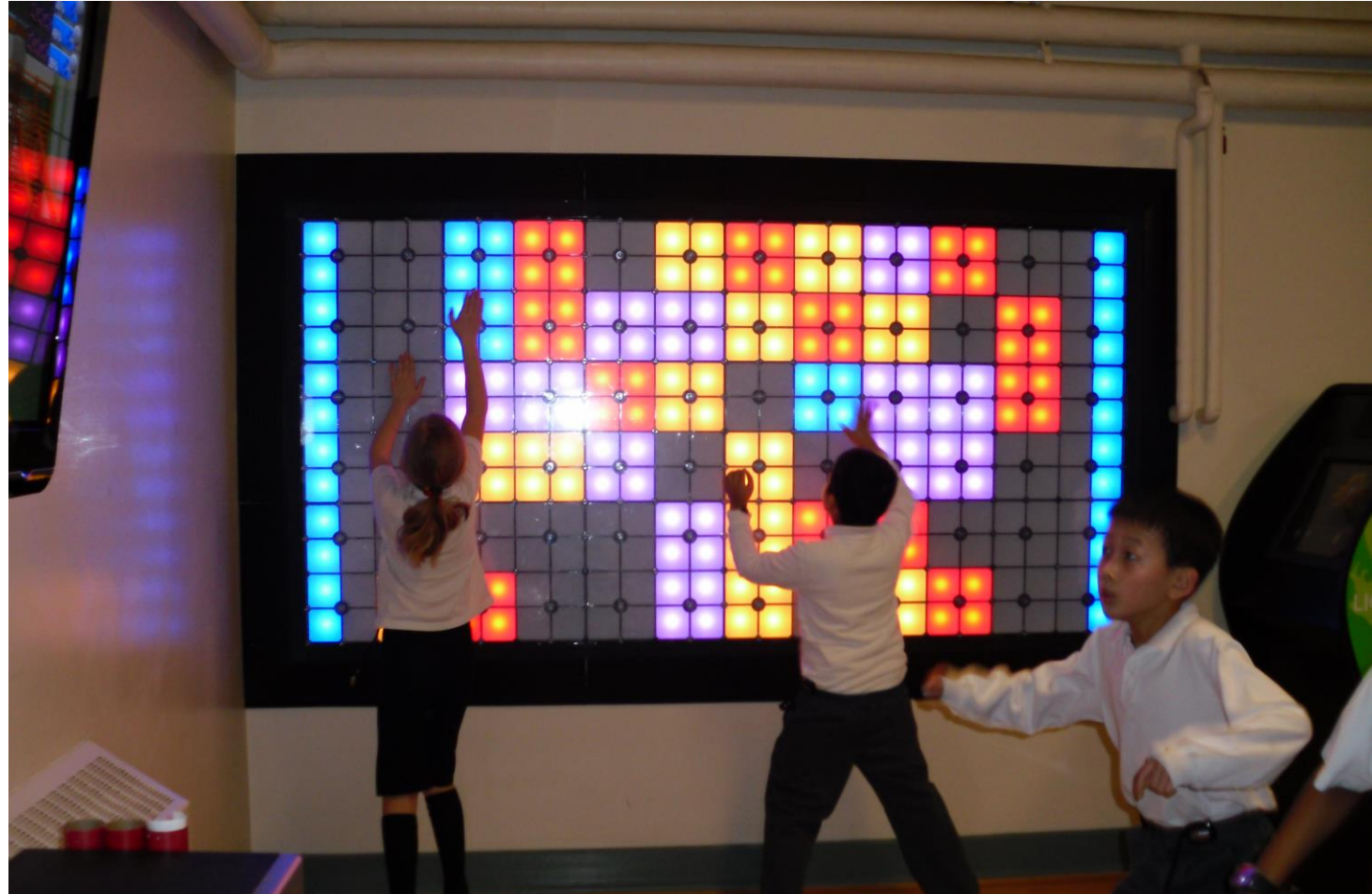


Interests,  
Passions,  
& Lived Experiences

# LIFE RELEVANT INQUIRY EXPERIENCES



Fitness Trackers for  
Math



Exergaming for Health Knowledge

# COLLABORATIVE & COLLECTIVE INQUIRY

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# COLLABORATIVE & COLLECTIVE INQUIRY

## **Small Groups**

Ask Questions

Design Experiments

Collect Data

Develop Claims

# COLLABORATIVE & COLLECTIVE INQUIRY

## Small Groups

Ask Questions

Design Experiments

Collect Data

Develop Claims

## Whole Classrooms

Collaboratively  
Negotiate Problems

Work Toward a  
Common Goal

How can **LPSV tools** support **life-relevant, collaborative** STEM learning experiences for youth?

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BodyVis  
(LPSV)

How can **LPSV tools** support **life-relevant, collaborative** STEM learning experiences for youth?

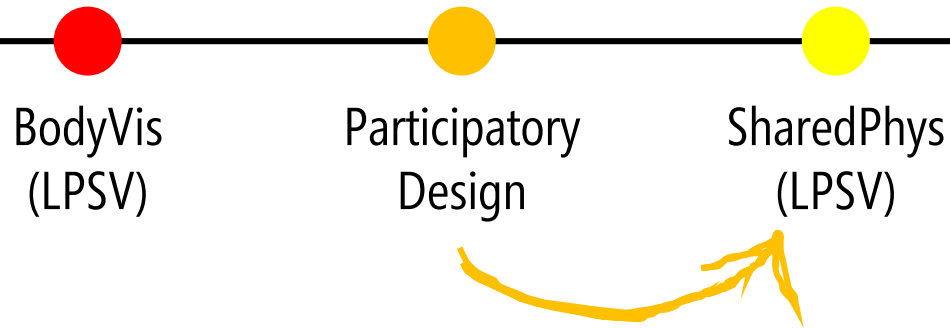


BodyVis  
(LPSV)

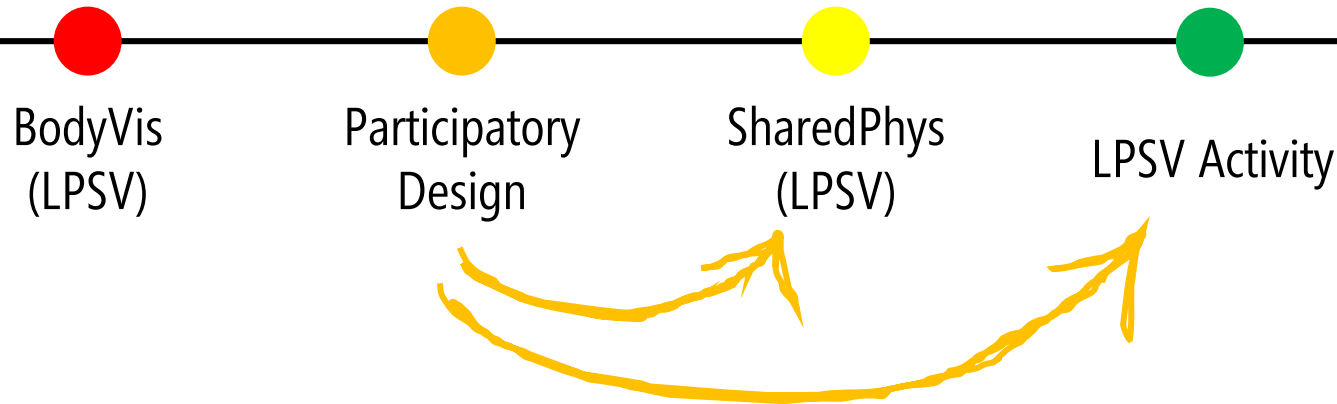


Participatory  
Design

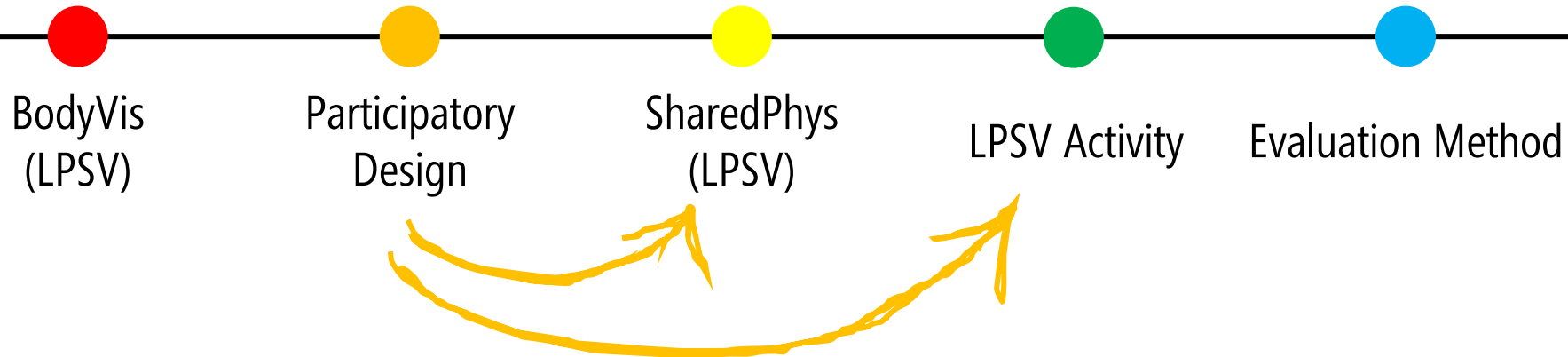
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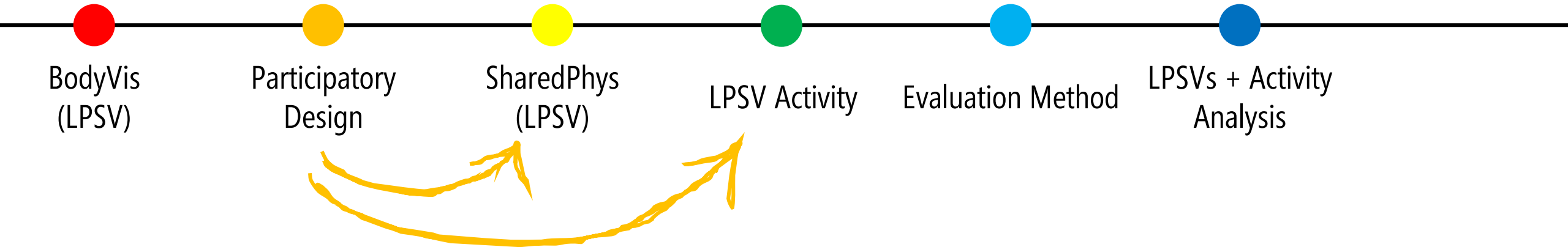


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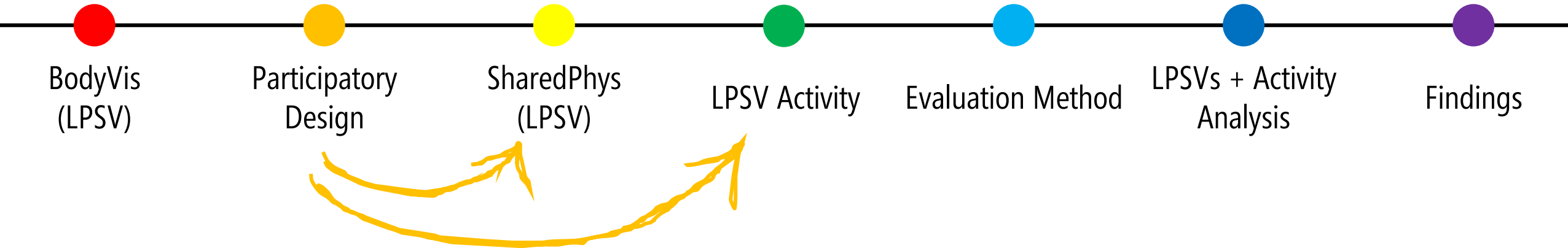




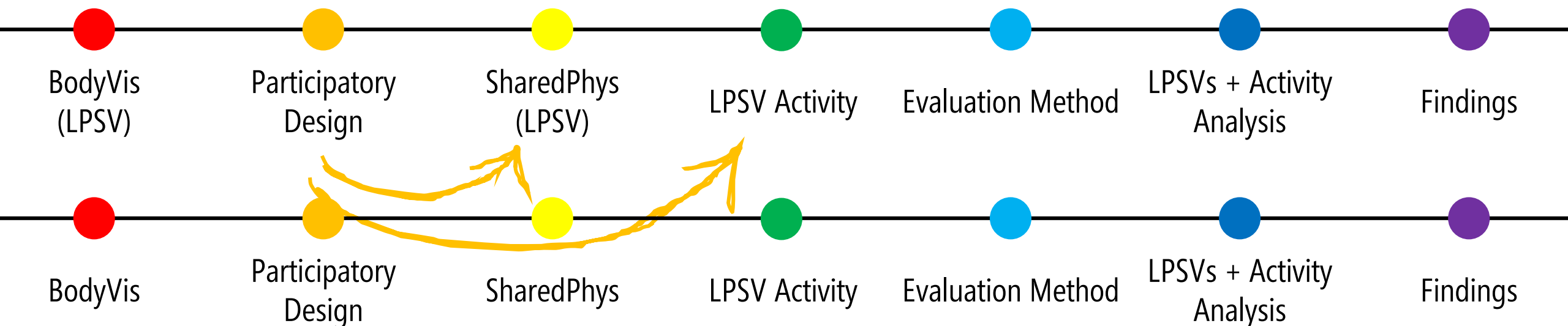
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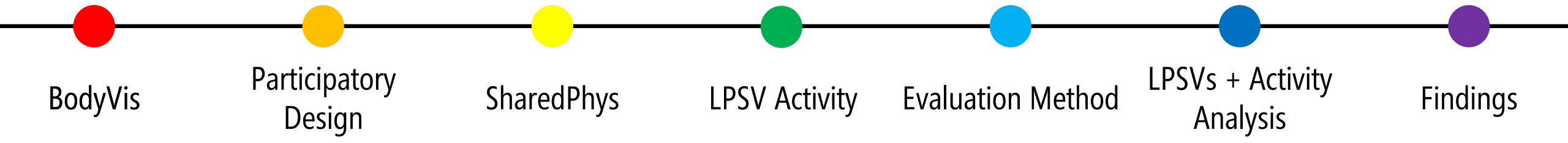


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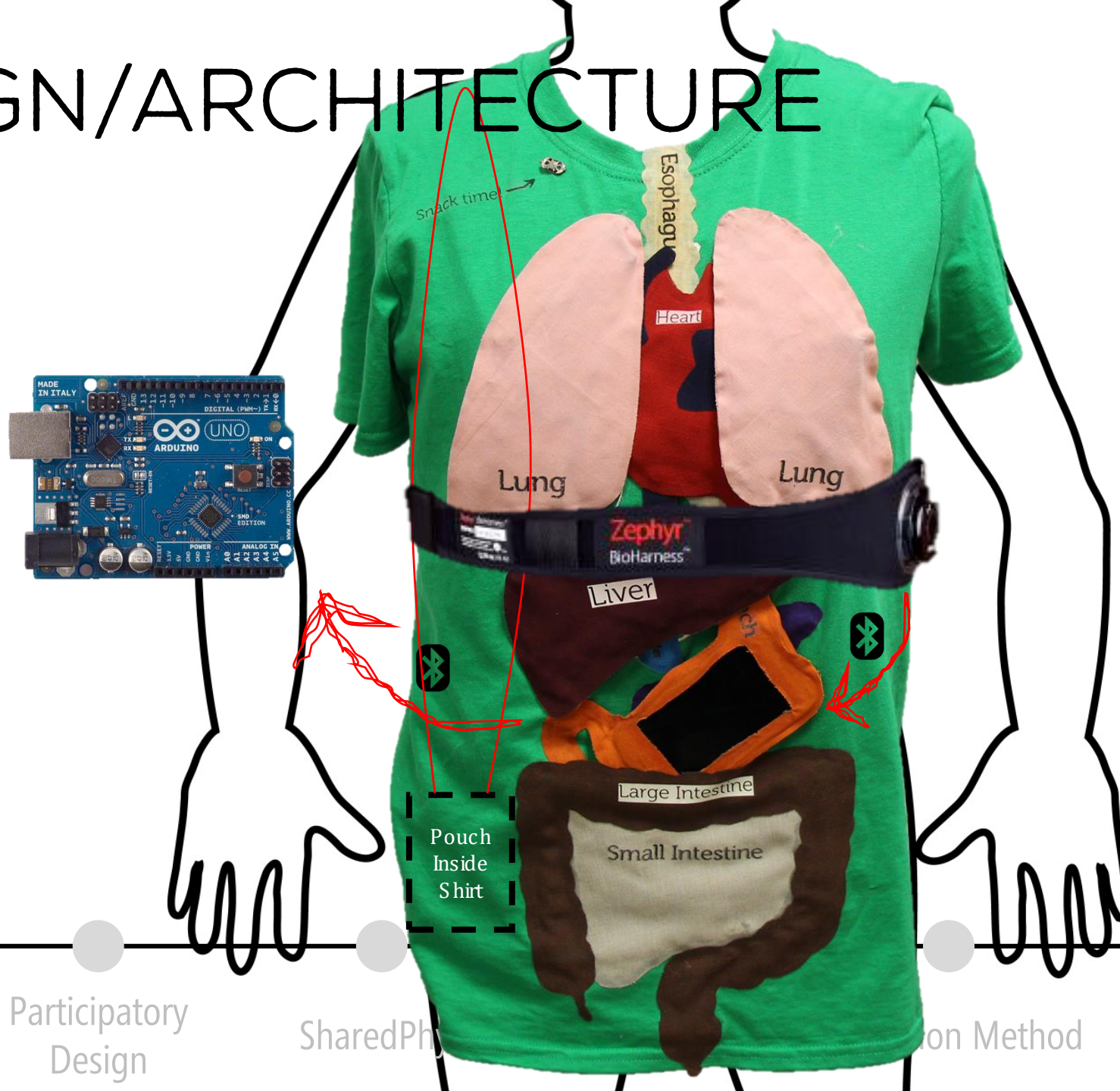


# How can **LPSV tools** support **life-relevant, collaborative** STEM learning experiences for youth?





# DESIGN/ARCHITECTURE



BodyVis

Participatory  
Design

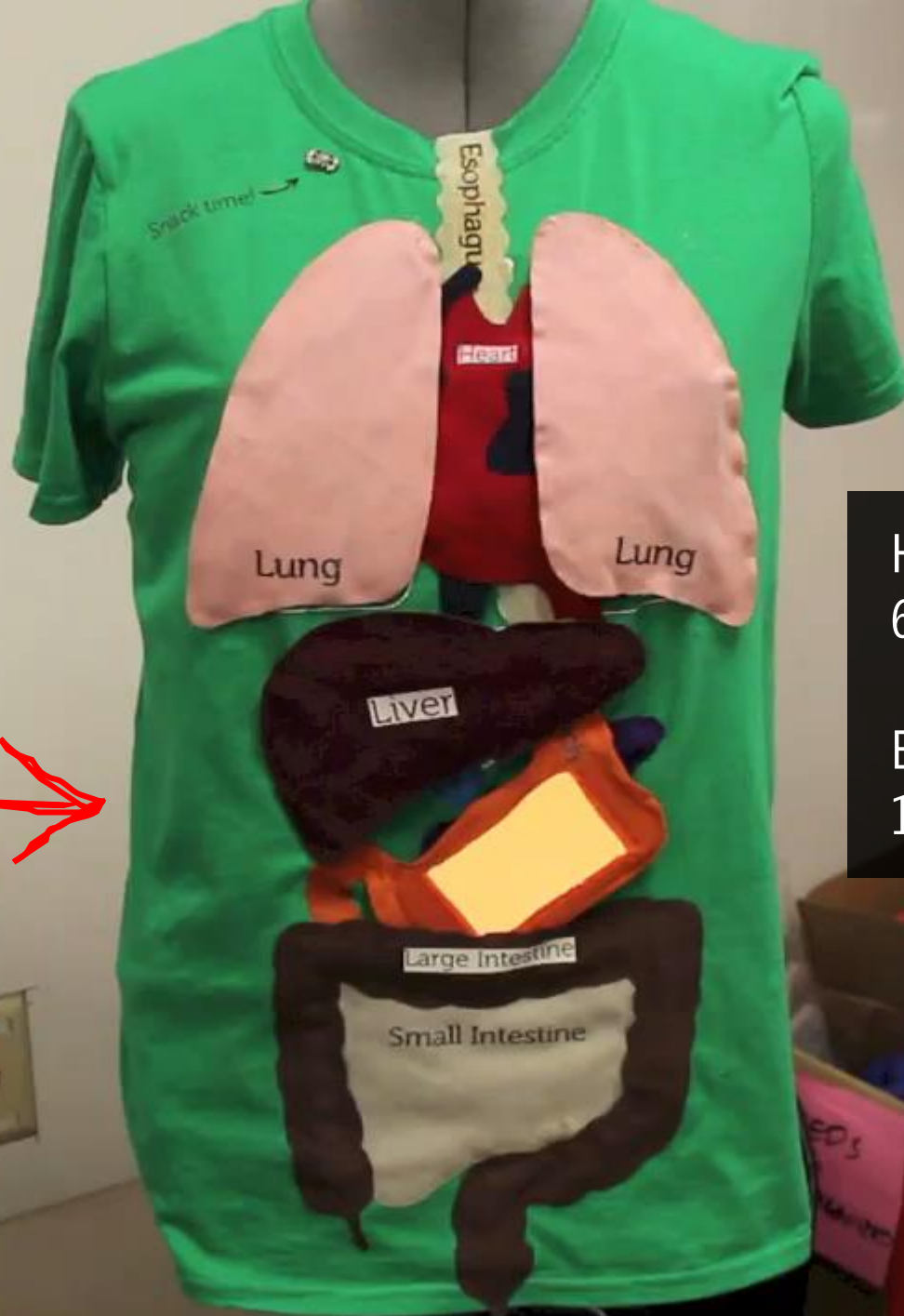
SharedPhy

on Method

LPSVs + Activity  
Analysis

Findings

See Norooz et al.,  
2015 for more



Heart Rate:  
60 bpm

Breathing Rate:  
15 bpm



BodyVis

Participatory  
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SharedPhys

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BodyVis

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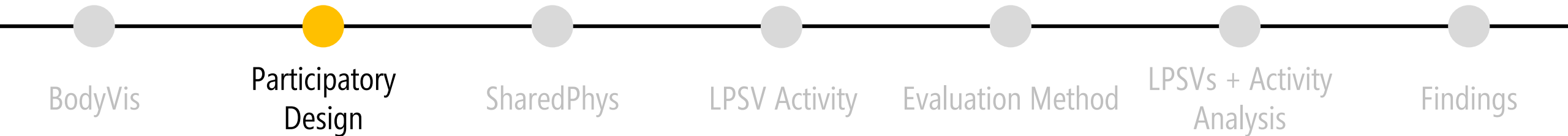


# ACTIVITY DESIGN



# ACTIVITY DESIGN

## Participatory Design

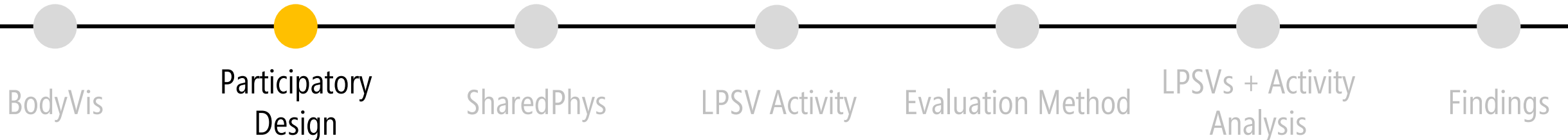


# ACTIVITY DESIGN

## Participatory Design

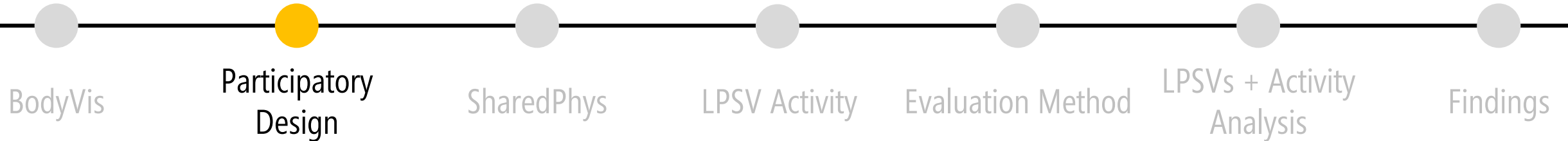
### Goal

To collaboratively design learning activities that utilized our LPSV tools



# ACTIVITY DESIGN

## Participatory Design



# ACTIVITY DESIGN

## Participatory Design

**Children**



**Teachers**



BodyVis

Participatory  
Design

SharedPhys

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# ACTIVITY DESIGN

## Participatory Design



BodyVis

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# ACTIVITY DESIGN

## Participatory Design



BodyVis

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BodyVis

**Participatory  
Design**

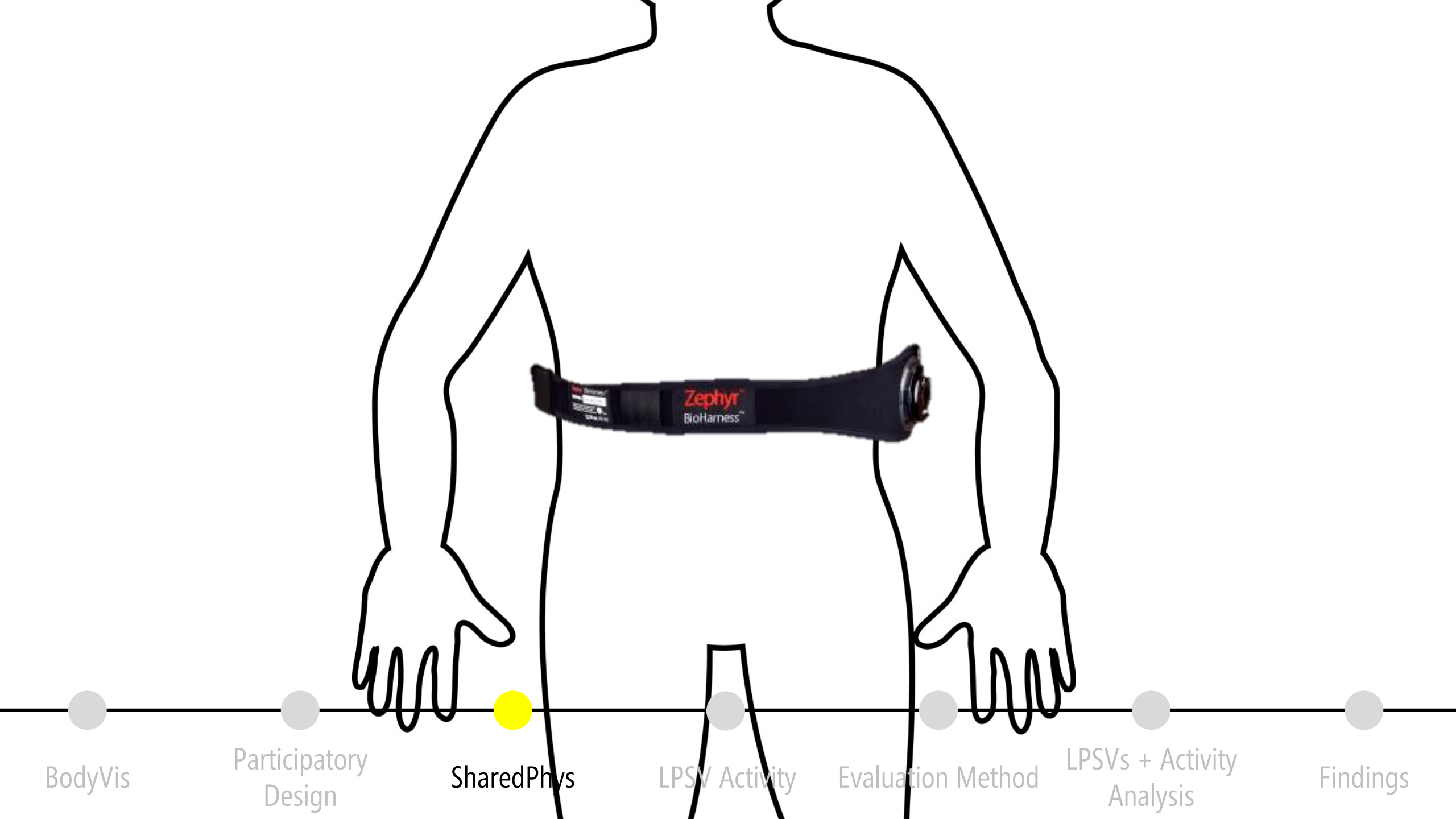
SharedPhys

LPSV Activity

Evaluation Method

LPSVs + Activity  
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Findings



# THREE DESIGNS



BodyVis

Participatory Design

SharedPhys

LPSV Activity

Evaluation Method

LPSVs + Activity Analysis

Findings

# THREE DESIGNS

## Magic Mirror

Basic human **physiology & anatomy**

## Animal Avatar

Structures and processes **across animals**

## Moving Graphs

Relating **health and human activity**

BodyVis

Participatory Design

SharedPhys

LPSV Activity

Evaluation Method

LPSVs + Activity Analysis

Findings

# THREE DESIGNS

## Magic Mirror

Basic human **physiology & anatomy**

## Animal Avatar

Structures and processes **across animals**

## Moving Graphs

Relating **health and human activity**

BodyVis

Participatory  
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LPSV Activity

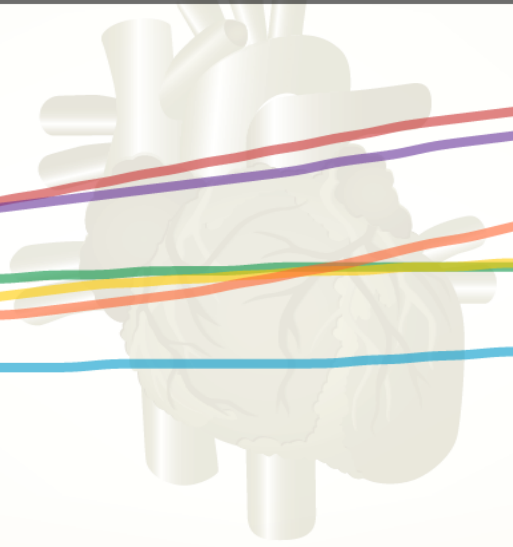
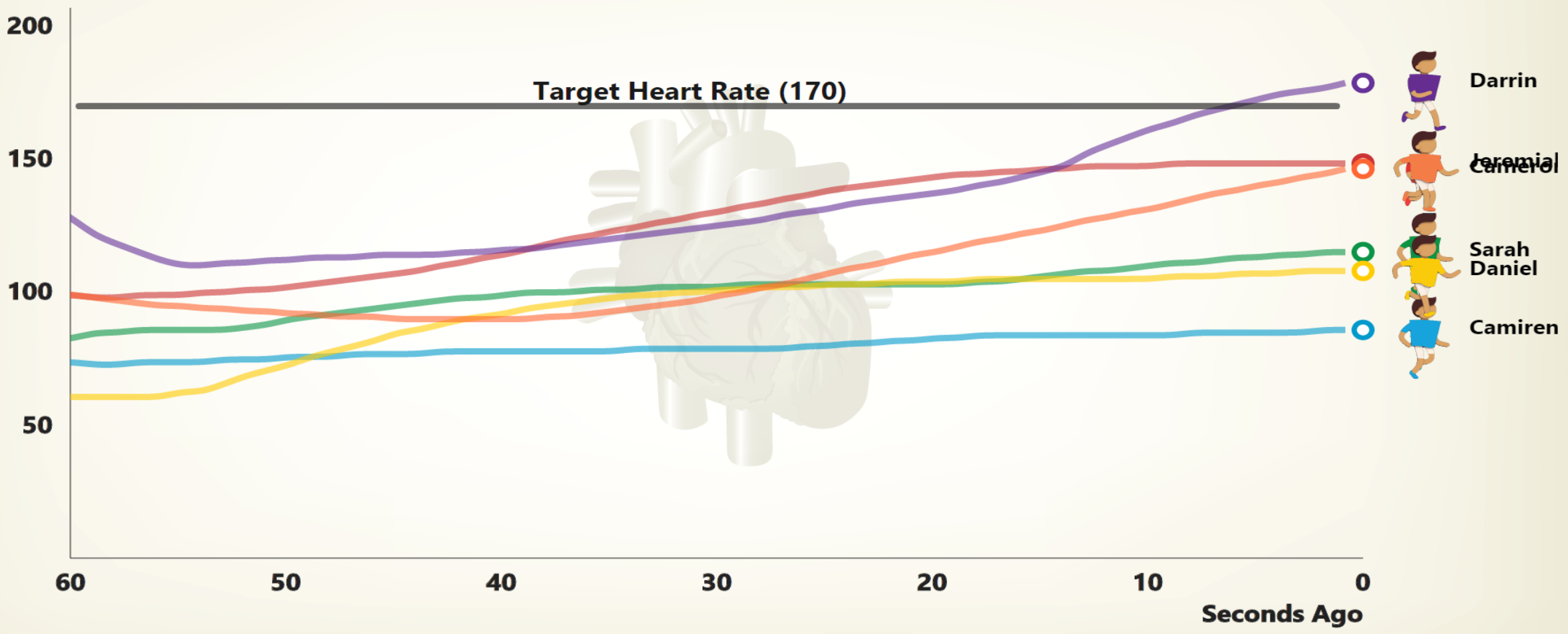
Evaluation Method

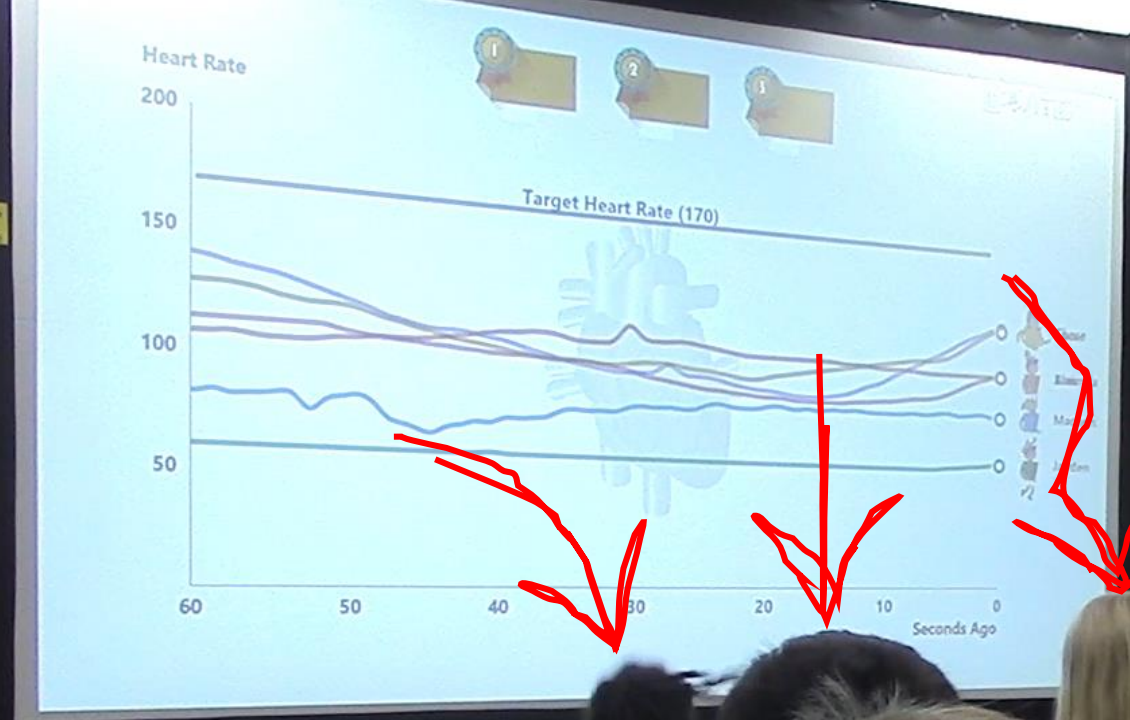
LPSVs + Activity  
Analysis

Findings



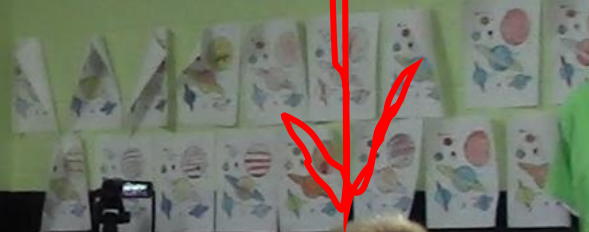
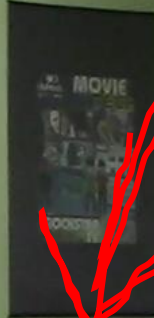
# Heart Rate





MARTIAN MONDAYS

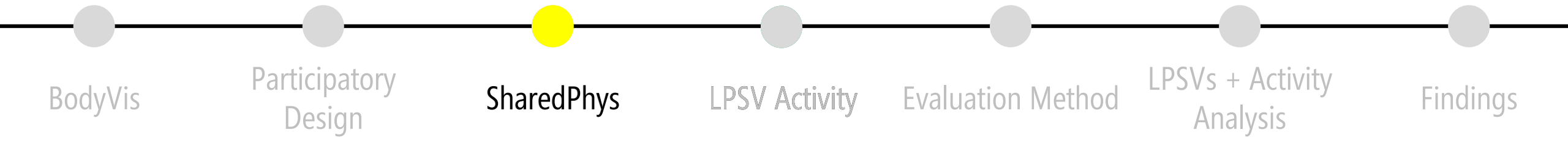
ENGINEERING DESIGN PROCESS  
ASK  
IMAGINE  
PLAN  
CREATE  
EVALUATE



# Moving Graphs









Hypothesize and test activities  
to lower and raise heart and  
breathing rates

BodyVis

Participatory  
Design

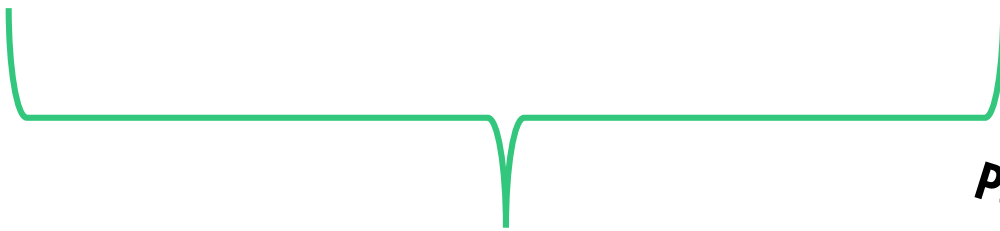
SharedPhys

LPSV Activity

Evaluation Method

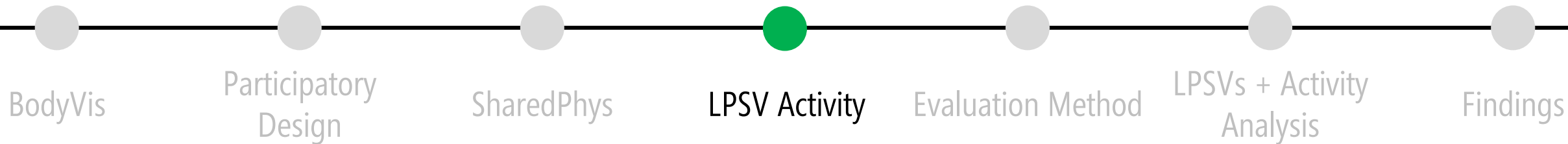
LPSVs + Activity  
Analysis

Findings



Hypothesize and test activities to lower and raise heart and breathing rates

**Participatory Design**





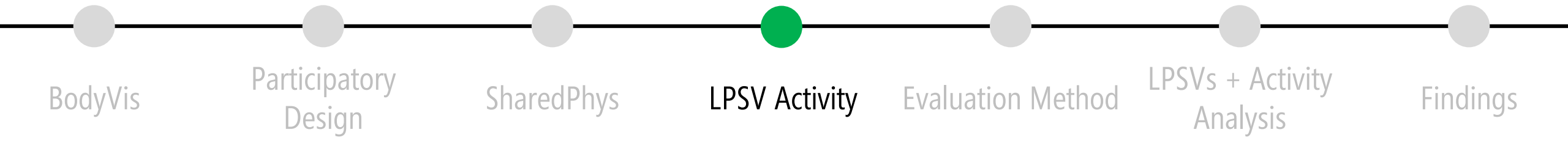
Small groups (BV) or pairs (SP) to brainstorm activities

Make predictions

Test with BodyVis or SharedPhys

Discuss results





BodyVis

Participatory  
Design

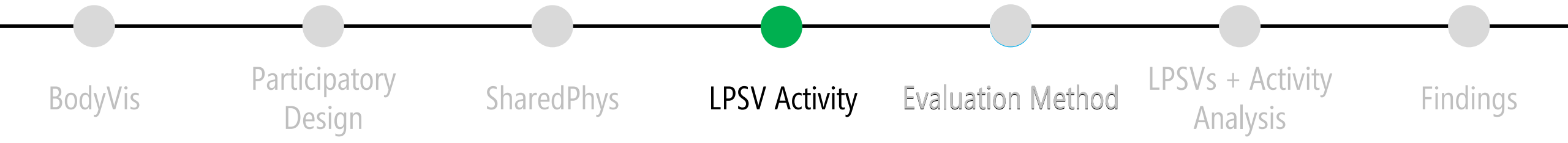
SharedPhys

LPSV Activity

Evaluation Method

LPSVs + Activity  
Analysis

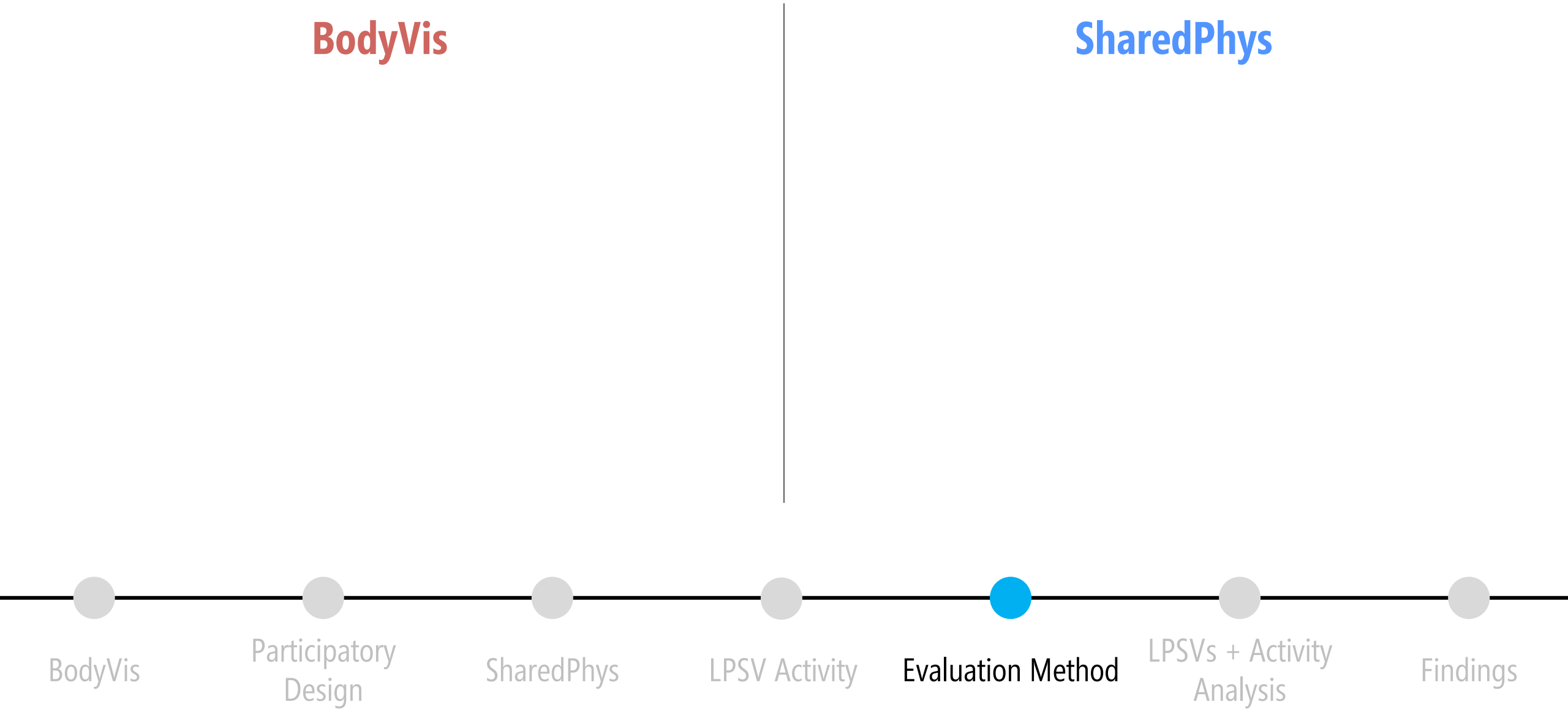
Findings



# SESSIONS

**BodyVis**

**SharedPhys**



BodyVis

Participatory  
Design

SharedPhys

LPSV Activity

Evaluation Method

LPSVs + Activity  
Analysis

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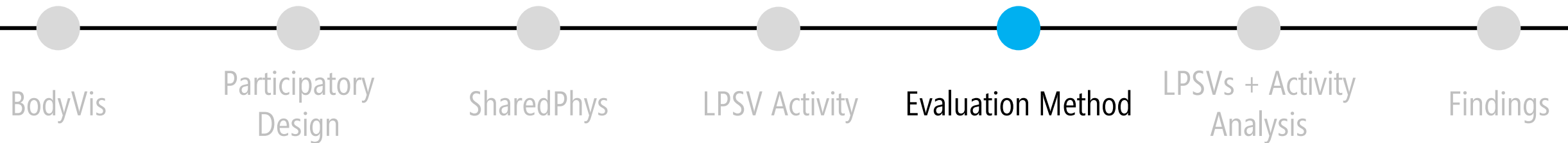


# SESSIONS

## BodyVis



## SharedPhys

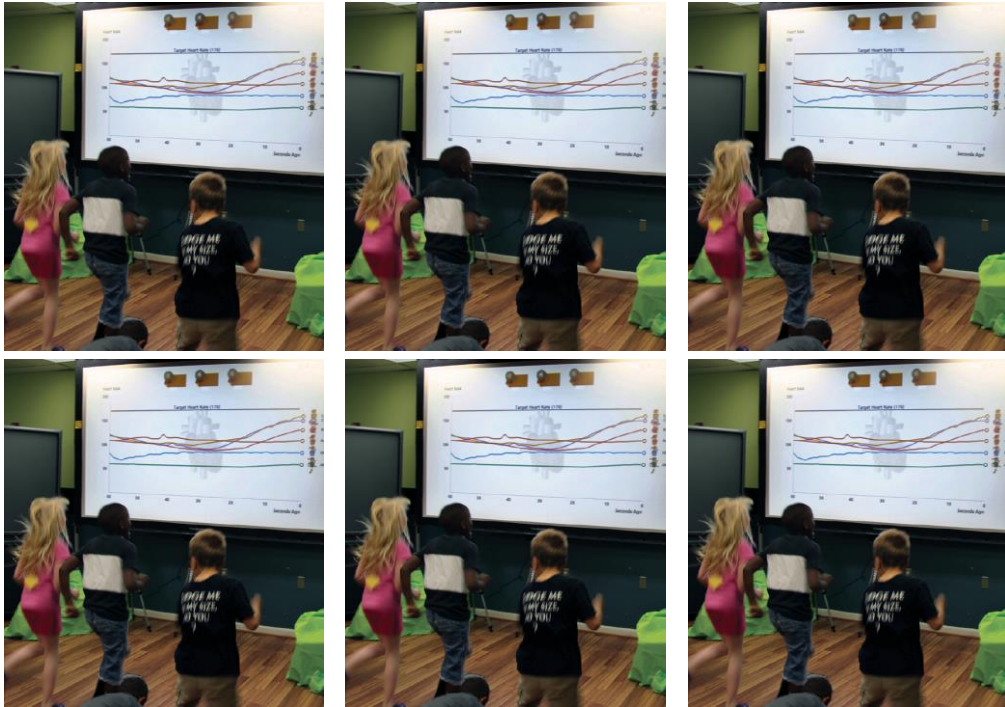


# SESSIONS

## BodyVis



## SharedPhys



BodyVis

Participatory Design

SharedPhys

LPSV Activity

Evaluation Method

LPSVs + Activity Analysis

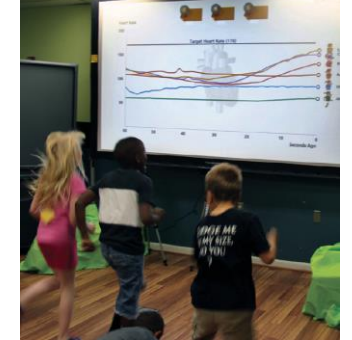
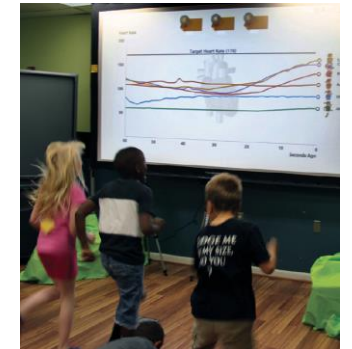
Findings

# SESSIONS

Joint 2<sup>nd</sup> and 3<sup>rd</sup> grade private school classroom



Out of school programs (Boys & Girls Club)



BodyVis

Participatory Design

SharedPhys

LPSV Activity

Evaluation Method

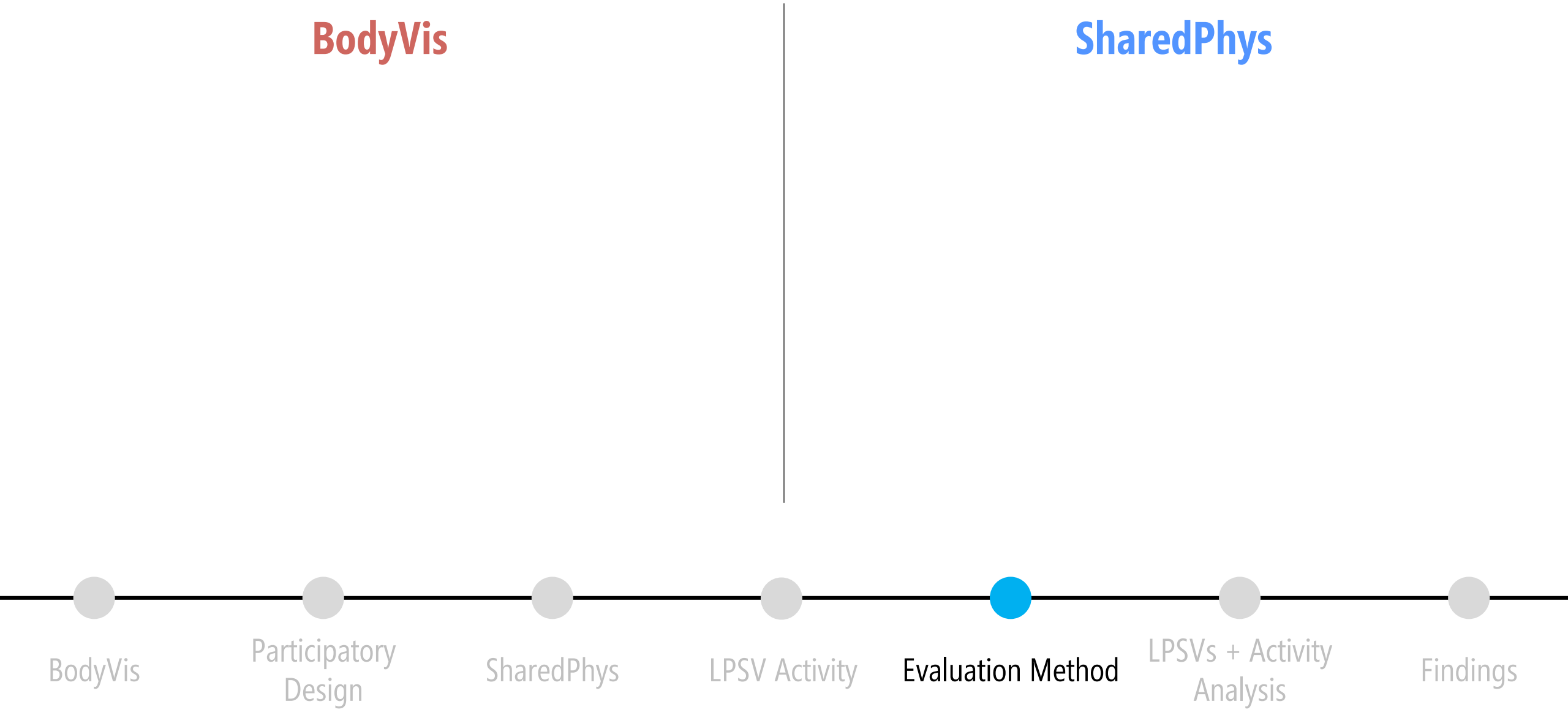
LPSVs + Activity Analysis

Findings

# PARTICIPANTS

**BodyVis**

**SharedPhys**



# PARTICIPANTS

## BodyVis

6-13

Ages



34 Male

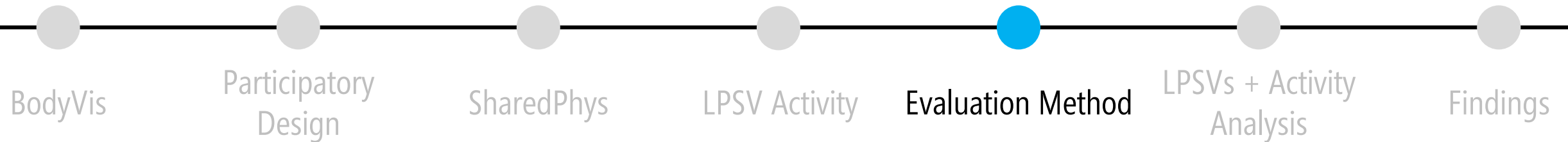
61

Participants



27 Female

## SharedPhys



# PARTICIPANTS

## BodyVis

6-13

Ages



34 Male

61

Participants



27 Female

## SharedPhys

5-13

Ages



42 Male

69

Participants



27 Female

BodyVis

Participatory  
Design

SharedPhys

LPSV Activity

Evaluation Method

LPSVs + Activity  
Analysis

Findings



BodyVis

Participatory  
Design

SharedPhys

LPSV Activity

**Evaluation Method**

LPSVs + Activity  
Analysis

Findings



BodyVis

Participatory  
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LPSV Activity

**Evaluation Method**

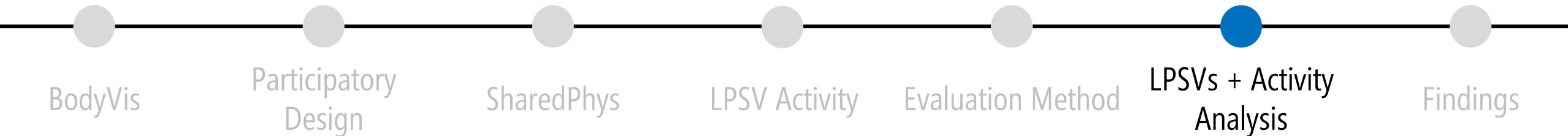
LPSVs + Activity  
Analysis

Findings



# ANALYSIS

We followed Chi's eight-step process (1997) using a mixed deductive and inductive approach



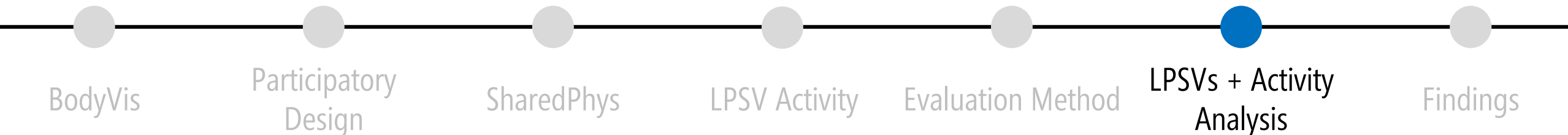
# ANALYSIS

## **Life-relevant Experiences**

Indicators of linking experiences to everyday life, demonstrations of excitement and curiosity

## **Collaboration**

Ways wearers and non-wearers interacted





BodyVis

Participatory  
Design

SharedPhys

LPSV Activity

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LPSVs + Activity  
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BodyVis

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# FINDINGS

Life-relevance

Collaboration



BodyVis



Participatory  
Design



SharedPhys



LPSV Activity



Evaluation Method



LPSVs + Activity  
Analysis

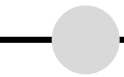


Findings

# FINDINGS

Life-relevance

Collaboration



BodyVis



Participatory  
Design



SharedPhys



LPSV Activity



Evaluation Method



LPSVs + Activity  
Analysis



Findings

# LIFE-RELEVANCE



Utilizing everyday activities to form hypotheses

BodyVis

Participatory  
Design

SharedPhys

LPSV Activity

Evaluation Method

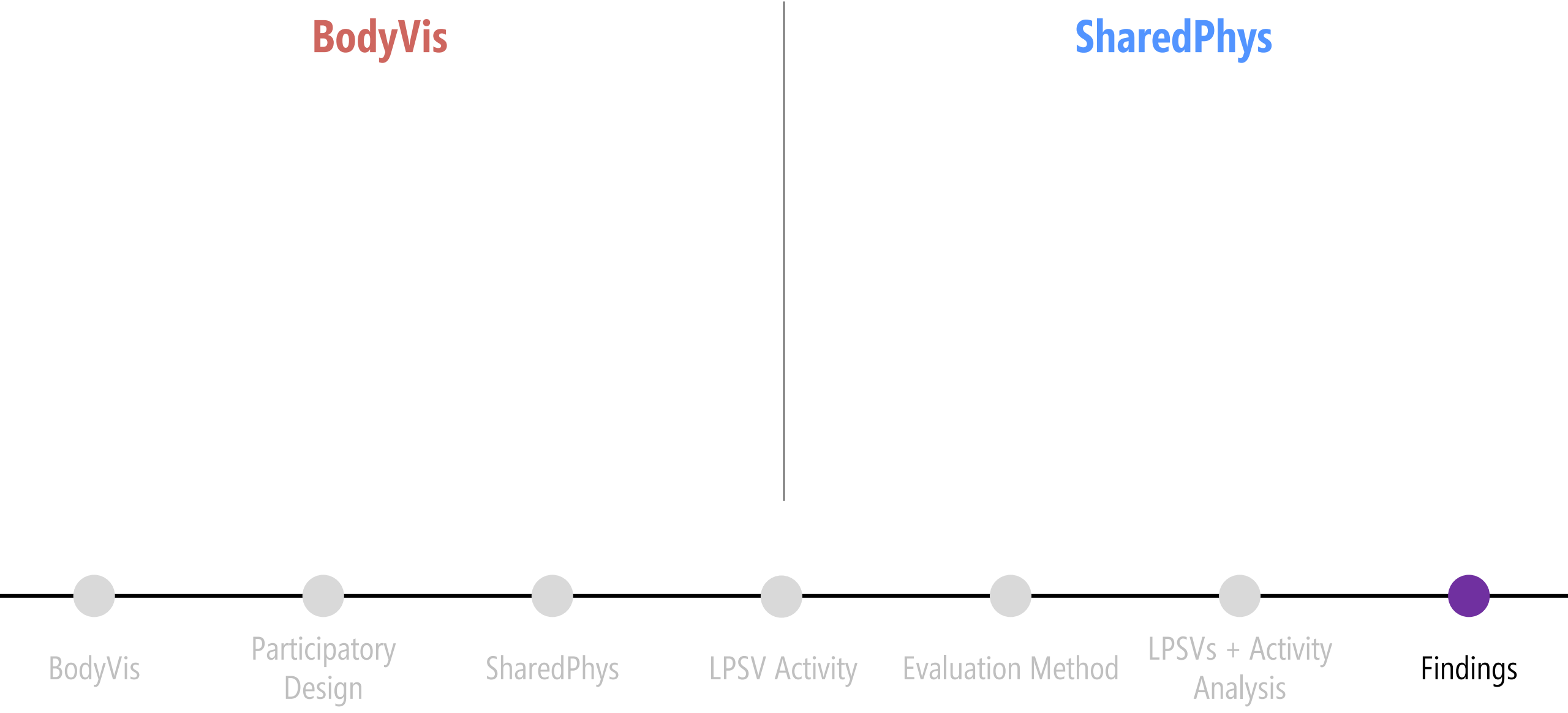
LPSVs + Activity  
Analysis

Findings

# LIFE-RELEVANCE

**BodyVis**

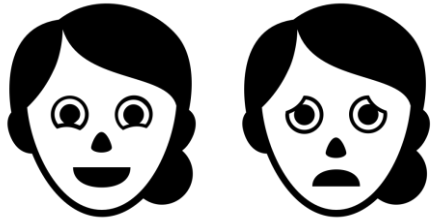
**SharedPhys**





# LIFE-RELEVANCE

BodyVis



Emotion → Physiology

SharedPhys





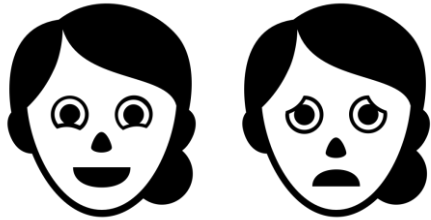
“

I kind of felt embarrassed because all these people were staring at me. So it kind of went up.

”

# LIFE-RELEVANCE

## BodyVis



Emotion → Physiology

## SharedPhys



Connection between  
bodies & visualization

BodyVis

Participatory  
Design

SharedPhys

LPSV Activity

Evaluation Method

LPSVs + Activity  
Analysis

Findings



WISE WEDNESDAY

FUN FRIDAY

PROFESSIONAL THURSDAY

IMAGINE INVENT INSPIRE

BodyVis

Participatory Design

SharedPhys

LPSV Activity

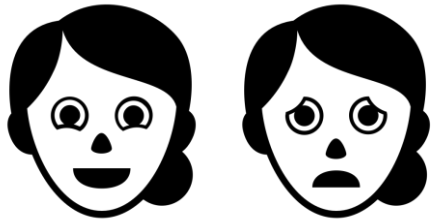
Evaluation Method

LPSVs + Activity Analysis

Findings

# LIFE-RELEVANCE

## BodyVis



Emotion → Physiology

## SharedPhys



Connection between  
bodies & visualization



Games and competition



BodyVis

Participatory  
Design

SharedPhys

LPSV Activity

Evaluation Method

LPSVs + Activity  
Analysis

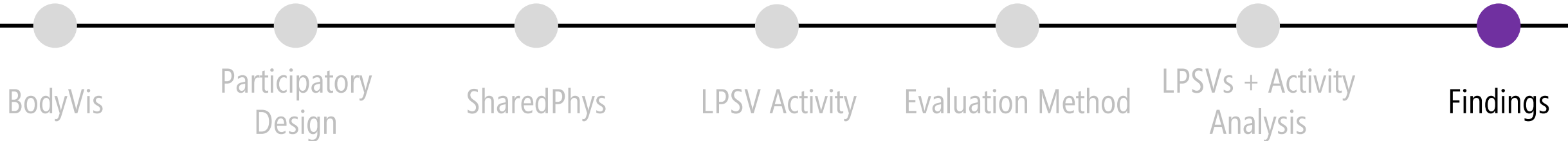
Findings



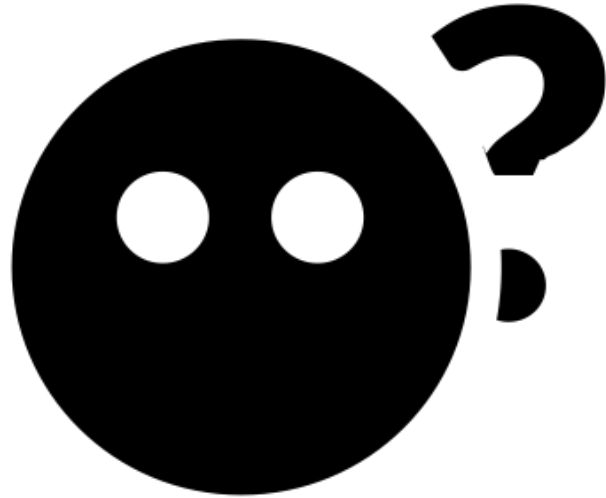
# FINDINGS

Life-relevance

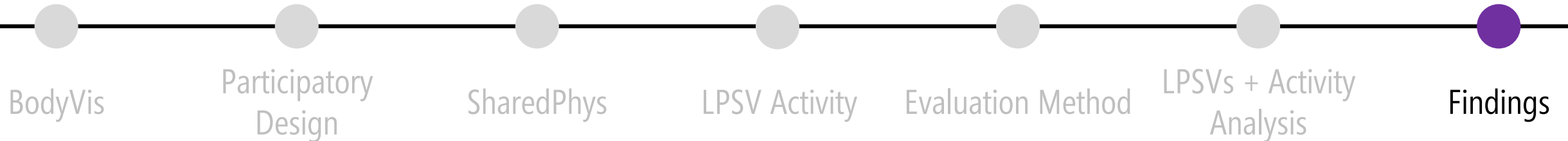
Collaboration



# COLLABORATION



Discussing proposed activities –  
unknown category





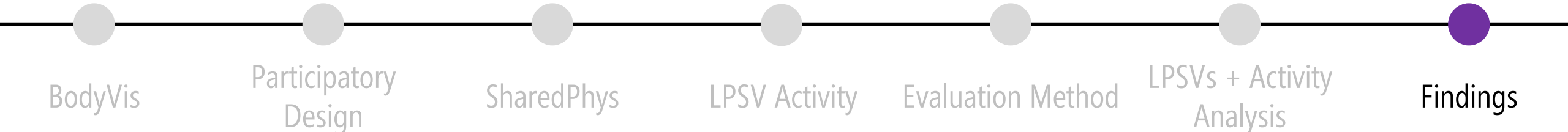
# COLLABORATION

**BodyVis**



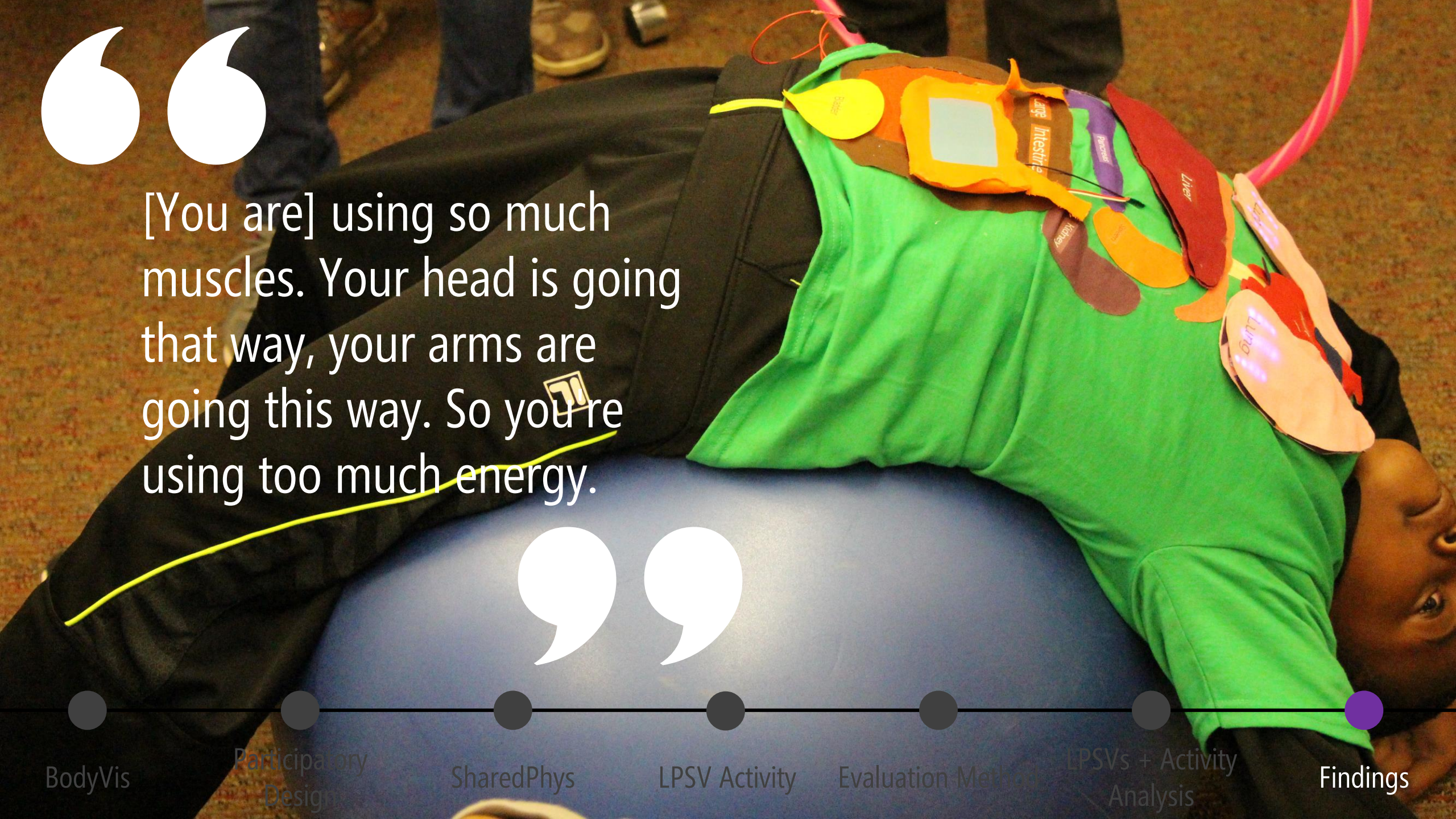
Discussing causes after each activity

**SharedPhys**





[You are] using so much muscles. Your head is going that way, your arms are going this way. So you're using too much energy.



BodyVis

Participatory Design

SharedPhys

LPSV Activity

Evaluation Method

LPSVs + Activity Analysis

Findings

# COLLABORATION

## BodyVis



Discussing causes after each activity



Changing predictions during discussion

## SharedPhys



BodyVis

Participatory Design

SharedPhys

LPSV Activity

Evaluation Method

LPSVs + Activity Analysis

Findings

# COLLABORATION

## BodyVis



Discussing causes after each activity



Changing predictions during discussion

## SharedPhys



Conversational collaboration between non-wearers





# COLLABORATION

## BodyVis



Discussing causes after each activity



Changing predictions during discussion

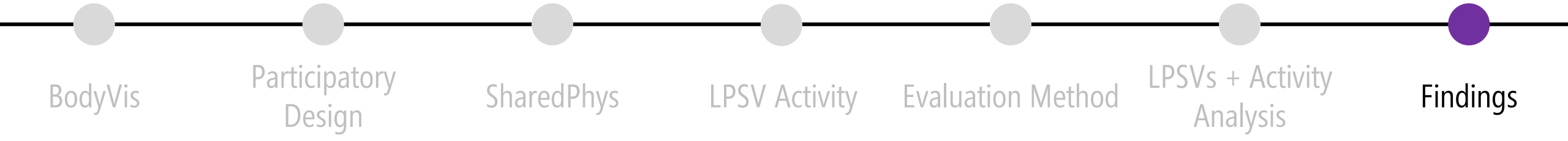
## SharedPhys



Conversational collaboration between non-wearers



Collaboration through physical action





BodyVis

Participatory Design

SharedPhys

LPSV Activity

Evaluation

LPSVs + Activity Analysis

Findings

GREAT FUTURES START HERE!

CHARACTER & LEADERSHIP  
EDUCATION & CAREERS

A young girl with long brown hair and a pink shirt is looking at a mannequin wearing a green shirt with a pink graphic. A young boy with dark hair and a blue shirt is also looking at the mannequin. The background shows a window with a view of a building and a white curtain.

How can **LPSV tools** support **life-relevant, collaborative** STEM learning experiences for youth?



# PERSONAL RELEVANCE



# PERSONAL RELEVANCE

Connecting **everyday physical activities** to organ function



# PERSONAL RELEVANCE

Connecting **everyday physical activities** to organ function



Carter Ching &  
Schaefer, 2015



# PERSONAL RELEVANCE

Connecting **everyday physical activities** to organ function



Connecting **social & emotional factors**

*Carter Ching & Schaefer, 2015*



# PERSONAL RELEVANCE

Connecting **everyday physical activities** to organ function

Connecting **social & emotional** factors

**Real-time visualizations**

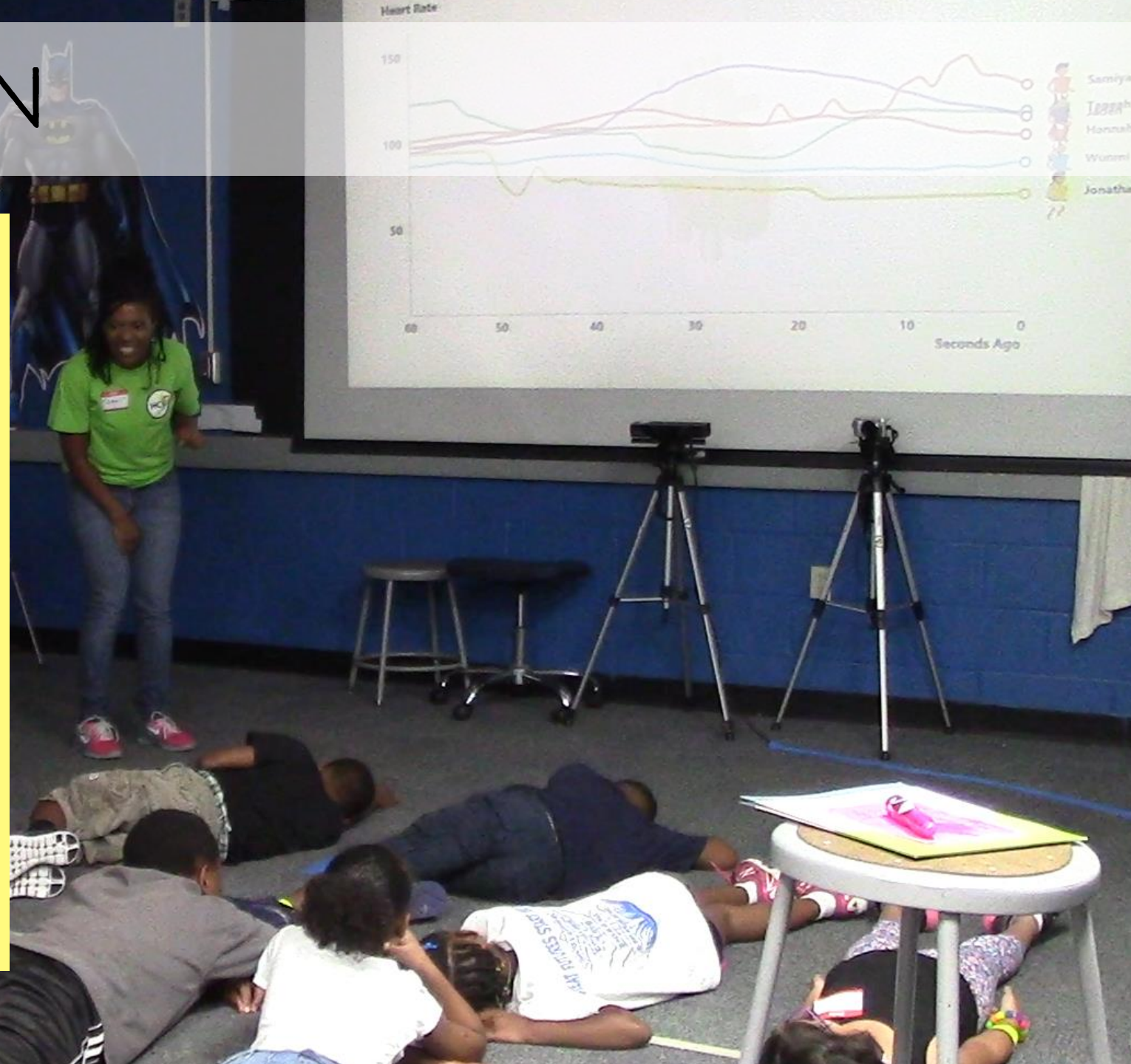


# COLLABORATION



# COLLABORATION

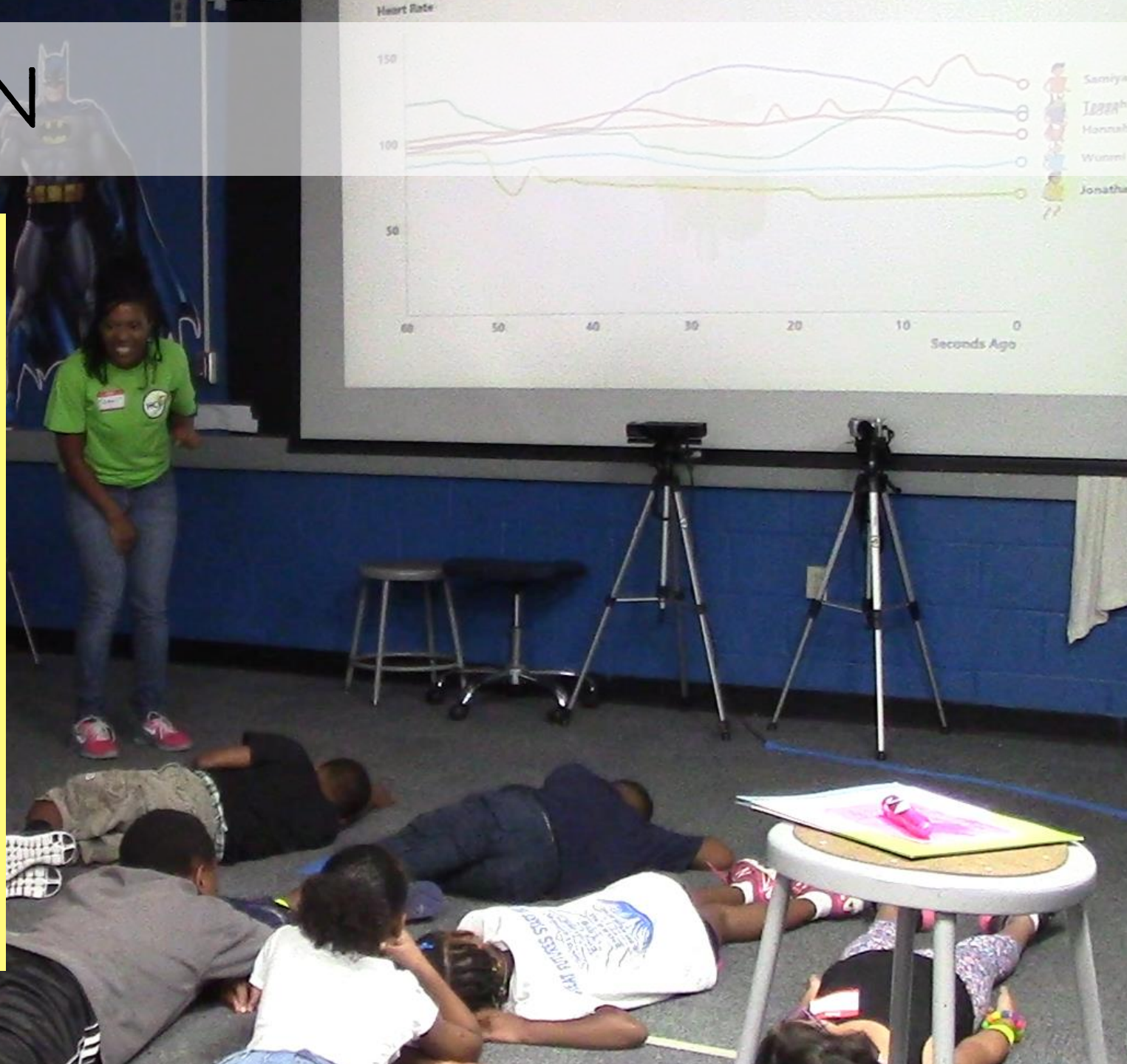
Collective **noticing**,  
**experimentations**, &  
**predictions**



# COLLABORATION

Collective **noticing**,  
**experimentations**, &  
**predictions**

Lee, 2015 &  
Lui et al., 2014



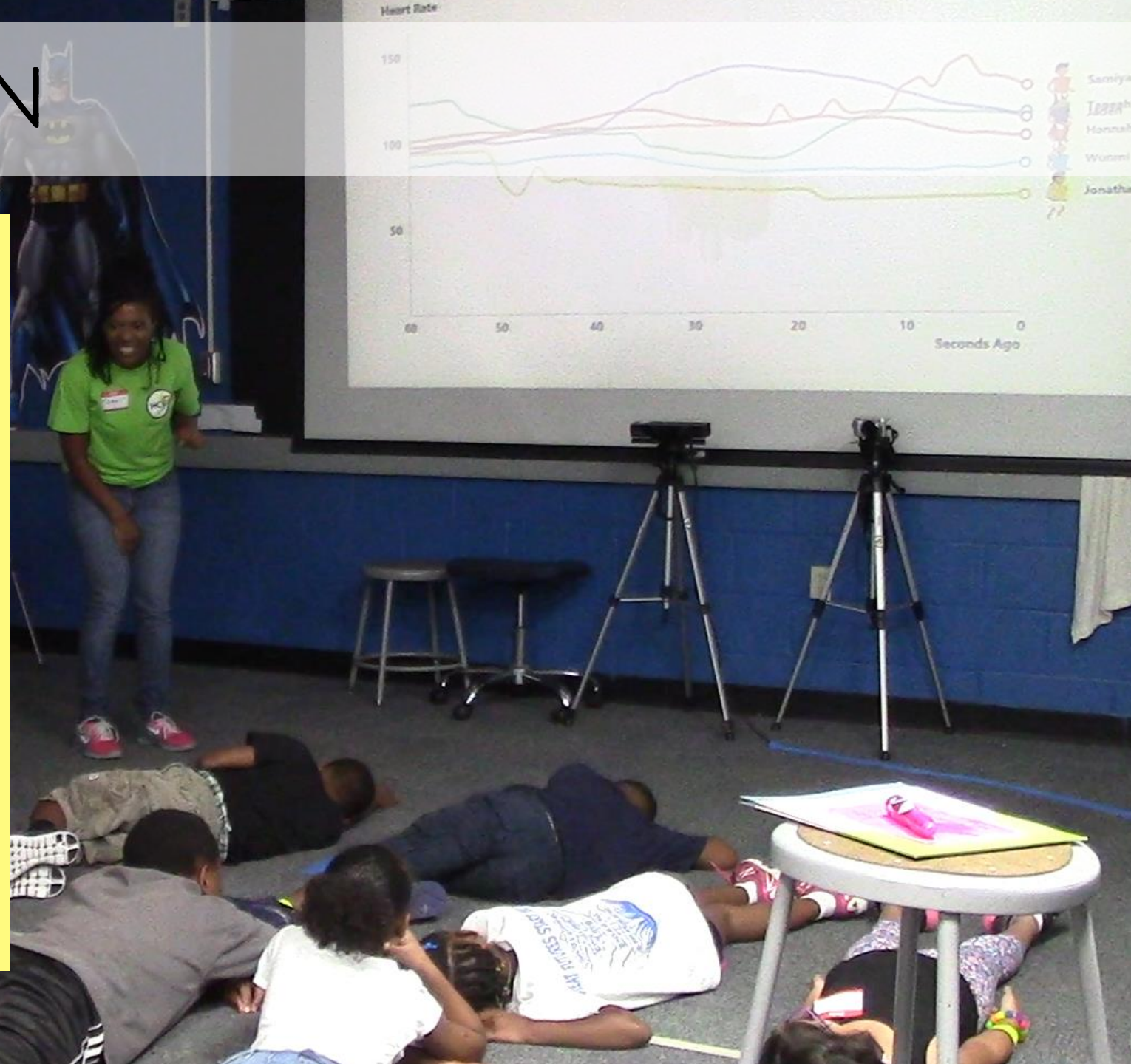


# COLLABORATION

Collective **noticing**,  
**experimentations**, &  
**predictions**

Collective **discussion**

*Lee, 2015 &  
Lui et al., 2014*

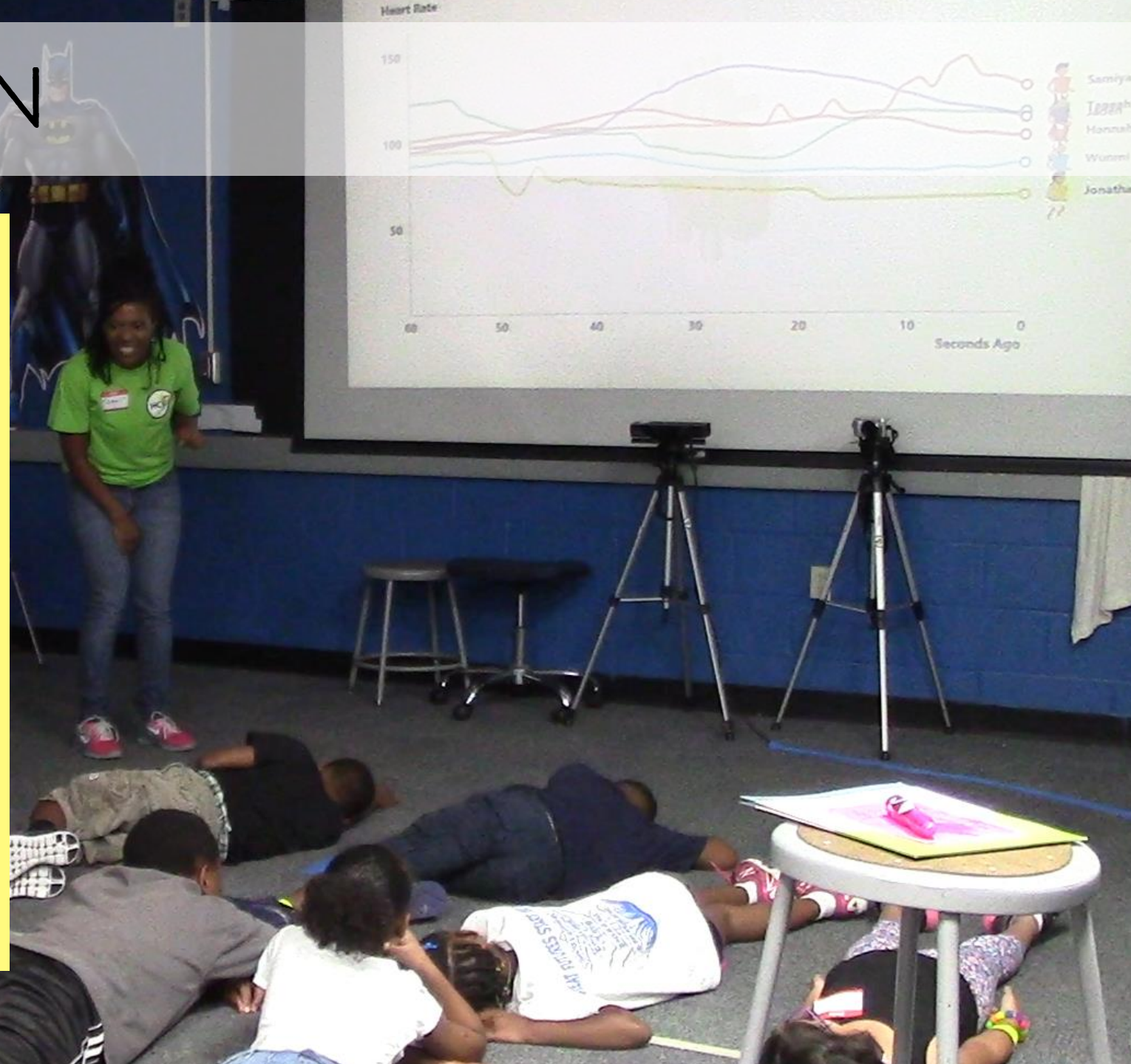


# COLLABORATION

Collective **noticing,**  
**experimentations, &**  
**predictions**

Collective **discussion**

Collective **physical activity**



# SOCIAL & EMOTIONAL EXPERIENCES



# SOCIAL & EMOTIONAL EXPERIENCES

Deeper understanding  
**beyond physiological  
concepts**

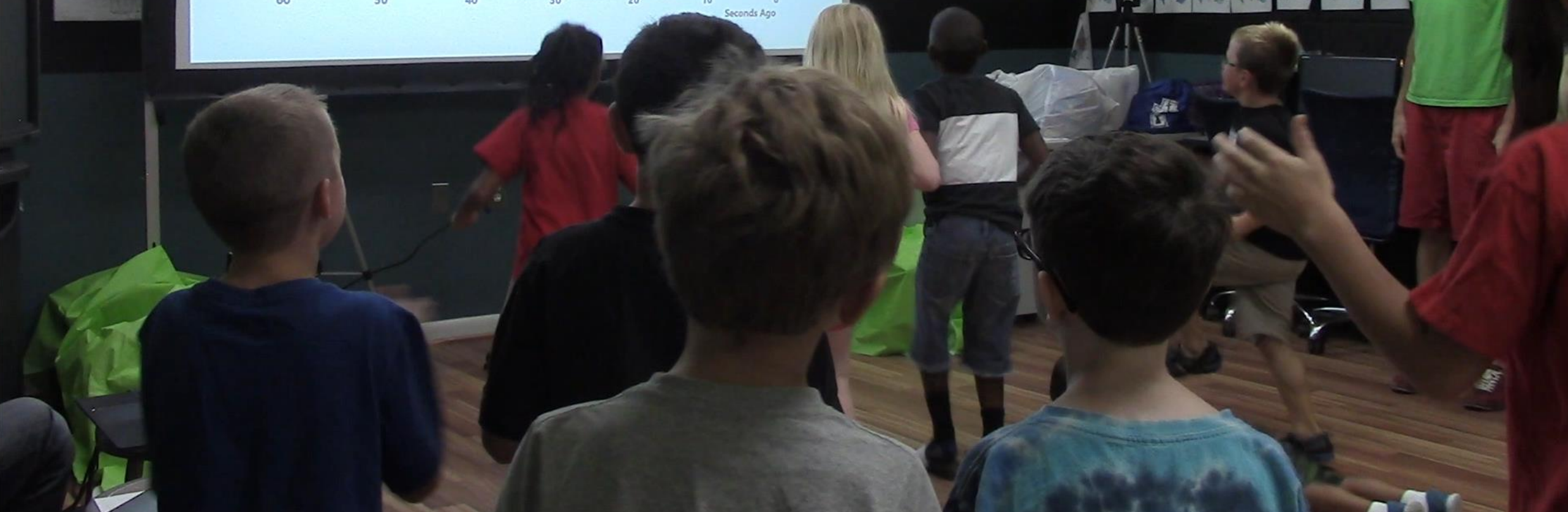


# MULTIPLE TYPES OF WEARER EXPERIENCES



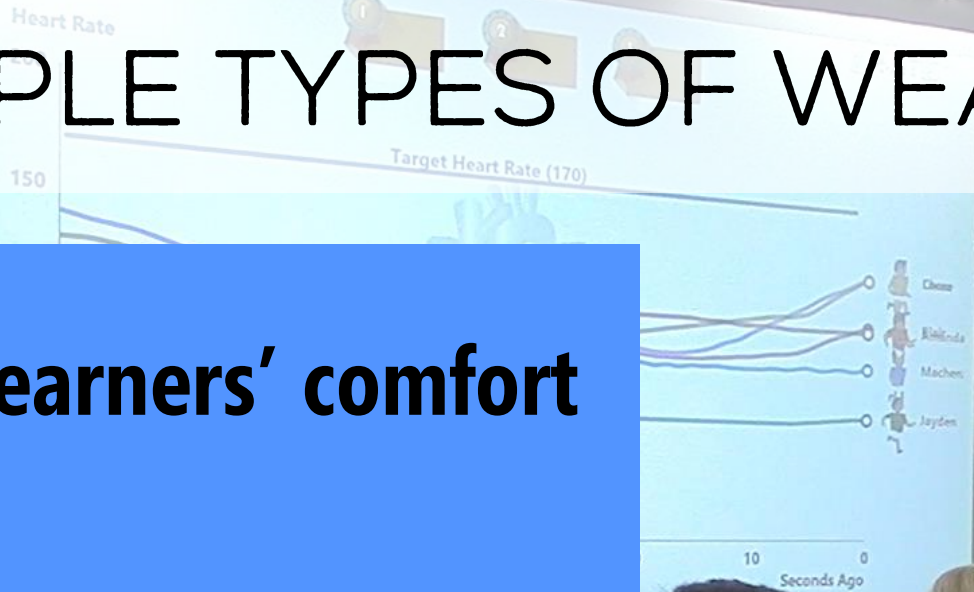
MARTIAN MONDAYS

ENGINEERING DESIGN PROCESS ASK Imagine Plan Create Experience

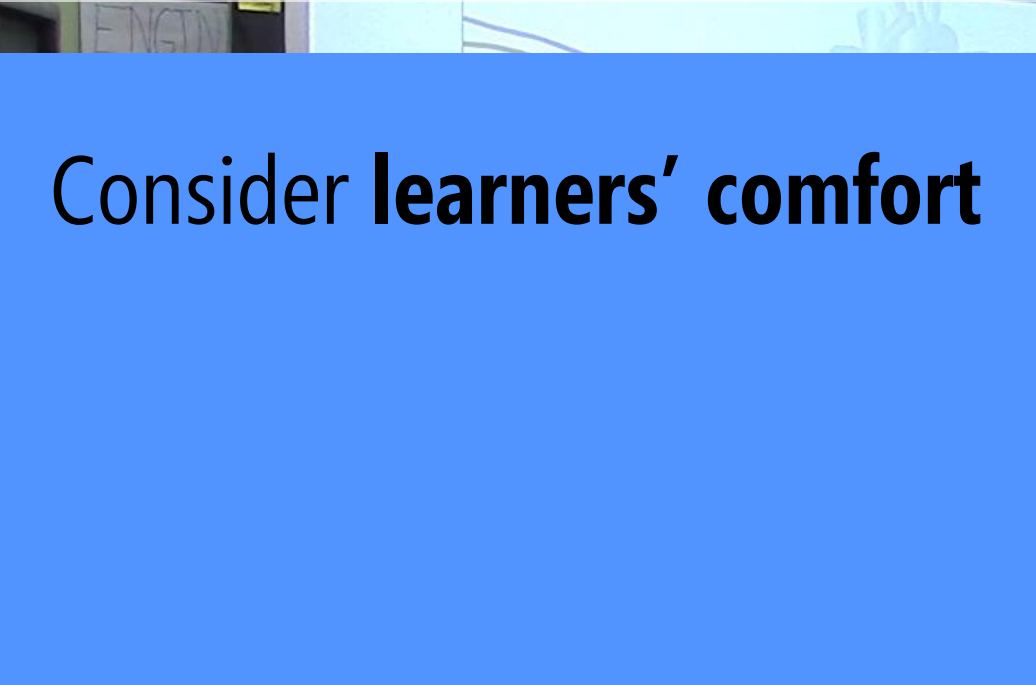


# MULTIPLE TYPES OF WEARER EXPERIENCES

Consider **learners' comfort**



MARTIAN MONDAYS



# MULTIPLE TYPES OF WEARER EXPERIENCES

Consider **learners' comfort**

Offer **multiple types of  
wearer experiences**



MARTIAN MONDAYS



A young girl with long brown hair, wearing a pink shirt, and a young boy with dark curly hair, wearing a blue shirt, are looking at a mannequin. The mannequin is wearing a green long-sleeved shirt. The background shows a window with a view of a building and a white curtain. The text "IN CLOSING ..." is overlaid in the center of the image.

IN CLOSING ...

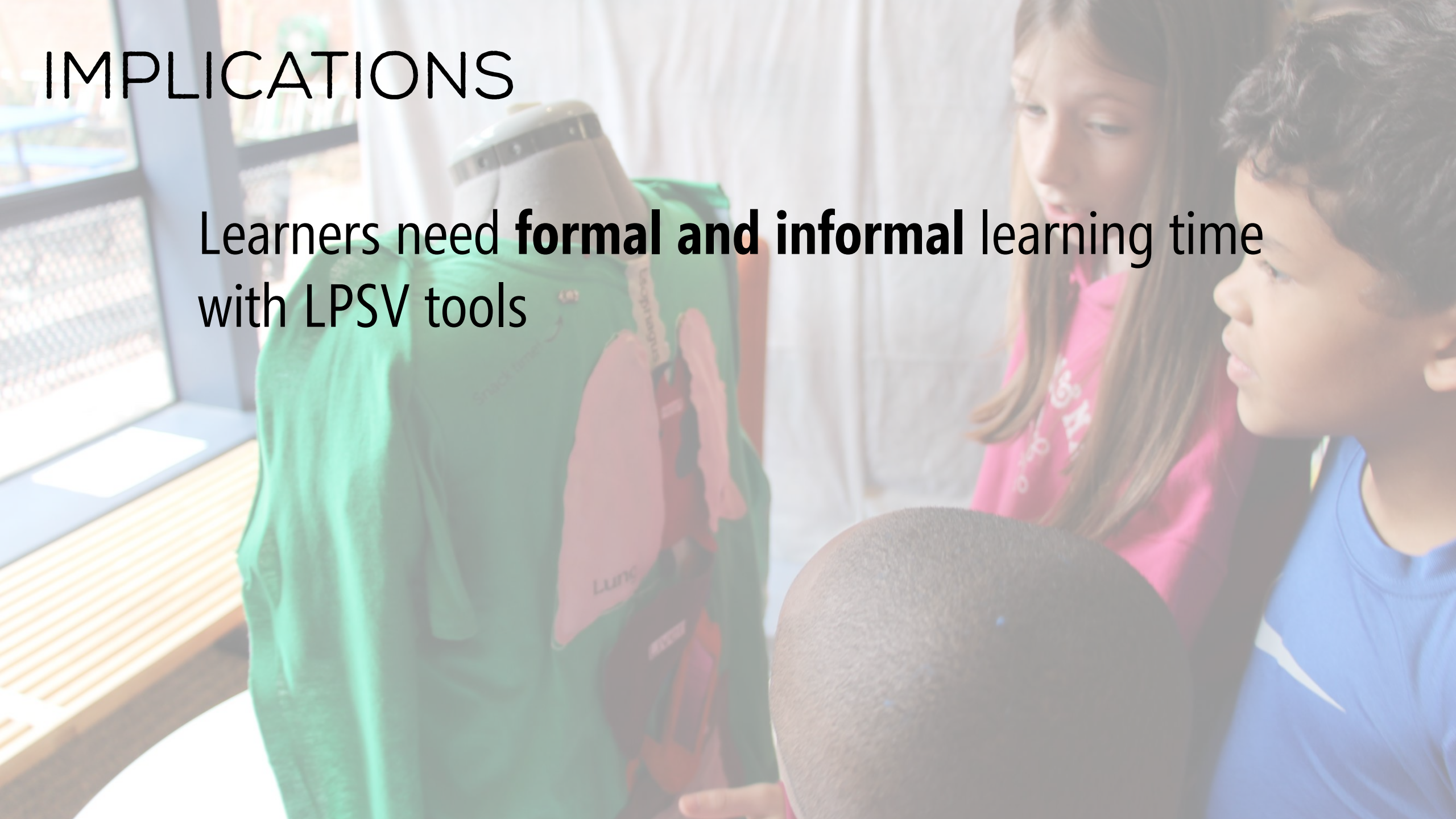


# IMPLICATIONS



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Learners need **formal and informal** learning time with LPSV tools



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Learners need **formal and informal** learning time with LPSV tools

Need opportunities to **wear & observe**



# IMPLICATIONS



Learners need **formal and informal** learning time with LPSV tools

Need opportunities to **wear & observe**

Learning contexts should be **flexible**

# The Team



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