"That's your heart!" Live Physiological Sensing & Visualization Tools for Life-Relevant & Collaborative STEM Learning

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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
How can LPSV tools support life-relevant, collaborative STEM learning experiences for youth?
LIFE RELEVANT INQUIRY EXPERIENCES

Clegg, Gardner, & Kolodner, ICLS 2010
LIFE RELEVANT INQUIRY EXPERIENCES

Science Inquiry & Learning

Interests, Passions, & Lived Experiences

Clegg, Gardner, & Kolodner, ICLS 2010
LIFE RELEVANT INQUIRY EXPERIENCES

[Image of a fitness tracker]
Fitness Trackers for Math

[Image of children playing a game]
Exergaming for Health Knowledge

Lee, 2015, Chapter 9; Carter Ching & Schaefer, 2015
COLLABORATIVE & COLLECTIVE INQUIRY
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Small Groups

- Ask Questions
- Design Experiments
- Collect Data
- Develop Claims

Chinn & Malhotra, 2001
Collaborative & Collective Inquiry

Small Groups
- Ask Questions
- Design Experiments
- Collect Data
- Develop Claims

Whole Classrooms
- Collaboratively Negotiate Problems
- Work Toward a Common Goal

Lui, Kuhn, Acosta, Quintana, & Slotta, CHI 2014  |  Lui, Slotta, & Cober, PUC Journal 2012
How can **LPSV tools** support **life-relevant, collaborative** STEM learning experiences for youth?
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DESIGN/ARCHITECTURE

Participatory Design Evaluation Method

Findings

BodyVis

LPSVs + Activity Analysis

SharedPhys

Pouch Inside Shirt
Heart Rate: 60 bpm
Breathing Rate: 15 bpm

See Norooz et al., 2015 for more
ACTIVITY DESIGN

- BodyVis
- Participatory Design
- SharedPhys
- LPSV Activity
- Evaluation Method
- LPSVs + Activity Analysis
- Findings
Participatory Design
Goal
To collaboratively design learning activities that utilized our LPSV tools
ACTIVITY DESIGN

Participatory Design

Children
ACTIVITY DESIGN

Participatory Design

Children

Teachers

BodyVis
Participatory Design
SharedPhys
LPSV Activity
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LPSVs + Activity Analysis
Findings
Participatory Design

Competitions
Games
Activity Design

Participatory Design

Competitions
Games

Experimenting high- and low-impact physical activities

BodyVis  Participatory Design  SharedPhys  LPSV Activity  Evaluation Method  LPSVs + Activity Analysis  Findings
Participatory Design Evaluation Method Findings LPSVs + Activity Analysis
Participatory Design Evaluation Method

LPSVs + Activity Analysis

BodyVis Participatory Design SharedPhys LPSV Activity Evaluation Method LPSVs + Activity Analysis Findings
THREE DESIGNS

BodyVis
Participatory Design
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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

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Heart Rate

Target Heart Rate (170)

- Darrin
- Camriel
- Sarah
- Daniel
- Camiren

BodyVis  Participatory Design  SharedPhys  LPSV Activity  Evaluation Method  LPSVs + Activity Analysis  Findings
Participatory Design Evaluation Method

Findings

LPSVs + Activity Analysis

BodyVis

Participatory Design

SharedPhys

LPSV Activity

Evaluation Method
Moving Graphs
Hypothesize and test activities to lower and raise heart and breathing rates.
Hypothesize and test activities to lower and raise heart and breathing rates.
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
BodyVis | Participatory Design | SharedPhys | LPSV Activity | Evaluation Method | LPSVs + Activity Analysis | Findings
Participatory Design Evaluation Method

Findings

LPSVs + Activity Analysis

BodyVis

Participatory Design

SharedPhys

LPSV Activity

Evaluation Method

Findings
SESSIONS

Joint 2\textsuperscript{nd} and 3\textsuperscript{rd} grade private school classroom

Out of school programs (Boys & Girls Club)
PARTICIPANTS

**BodyVis**

- Ages: 6-13
- Participants: 61
- Male: 34
- Female: 27

**SharedPhys**
PARTICIPANTS

**BodyVis**

- Ages: 6-13
- Participants: 61
- 34 Male
- 27 Female

**SharedPhys**

- Ages: 5-13
- Participants: 69
- 42 Male
- 27 Female
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
FINDINGS

Life-relevance

Collaboration
FINDINGS

Life-relevance

Collaboration
Utilizing everyday activities to form hypotheses
LIFE-RELEVANCE

BodyVis

SharedPhys

Findings
LIFE-RELEVANCE

BodyVis

Emotion → Physiology

SharedPhys

Participatory Design

SharedPhys

LPSV Activity

Evaluation Method

LPSVs + Activity Analysis

Findings
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
Participatory Design Evaluation Method

Findings

LPSVs + Activity Analysis
**LIFE-RELEVANCE**

**BodyVis**

Emotion → Physiology

**SharedPhys**

Connection between bodies & visualization

Games and competition
Participatory Design Evaluation Method

Findings

LPSVs + Activity Analysis

BodyVis  Participatory Design  SharedPhys  LPSV Activity  Evaluation Method  Activity Analysis  Findings
FINDINGS

Life-relevance

Collaboration

BodyVis  Participatory Design  SharedPhys  LPSV Activity  Evaluation Method  LPSVs + Activity Analysis  Findings
COLLABORATION

Discussing proposed activities – unknown category
Collaboration

**BodyVis**

Discussing causes after each activity

**SharedPhys**

**Findings**
[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.
COLLABORATION

BodyVis

Discussing causes after each activity

Changing predictions during discussion

SharedPhys

Findings

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
**BodyVis**
- Discussing causes after each activity
- Changing predictions during discussion

**SharedPhys**
- Conversational collaboration between non-wearers
- Collaboration through physical action
Participatory Design Evaluation Method

LPSVs + Activity Analysis

BodyVis
Participatory Design
SharedPhys
LPSV Activity
Evaluation Method
LPSVs + Activity Analysis
Findings
How can LPSV tools support life-relevant, collaborative STEM learning experiences for youth?
Connecting *everyday physical activities* to organ function
Connecting *everyday physical activities* to organ function

*Carter Ching & Schaefer, 2015*
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
Collective **noticing**, **experimentations**, & **predictions**
COLLABORATION

Collective **noticing, experimentations, & predictions**

Lee, 2015 & Lui et al., 2014
Collective noticing, experimentations, & predictions

Collective discussion, 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

Consider *learners’ comfort*
MULTIPLE TYPES OF WEARER EXPERIENCES

Consider **learners’ comfort**

Offer **multiple types of wearer experiences**
IN CLOSING...
Learners need **formal and informal** learning time with LPSV tools
IMPLICATIONS

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

Need opportunities to **wear & observe**
Learners need **formal and informal** learning time with LPSV tools

Need opportunities to **wear & observe**

Learning contexts should be **flexible**