Sensing Science Through Modeling Matter For Kindergarten

Kindergarten Students' Development of Understanding of Matter and Its Changes

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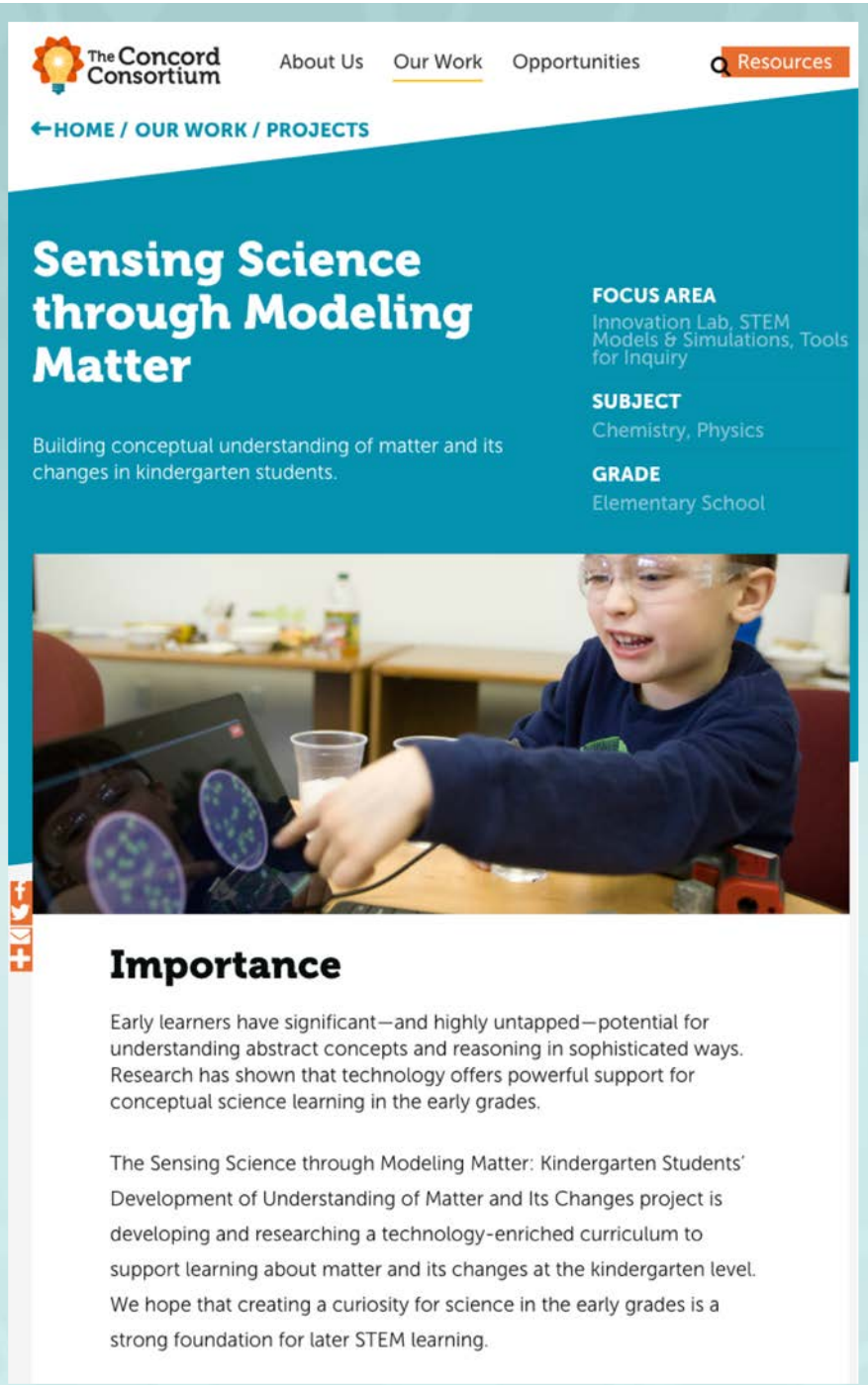


https://concord.org/projects/sensing-science

The Rationale

The Rationale for Sensing Science Through Modeling Matter (S2M2)

Students designing experiments using probes and handheld computers.

Young children learn by exploring their immediate world through everyday activities, developing intuitive understandings of phenomena that surround them. These intuitive understandings are long lasting and generally incorrect. Sensing Science Through Modeling Matter will test the hypothesis that models, representations, data collection and student reflection integrated into creative exploration can make learning about states of matter and phase change accessible to early elementary students.

Importance of Modeling at an Early Age

Early learners have significant—and highly untapped—potential for understanding abstract concepts and reasoning in sophisticated ways.

Research has shown that technology offers powerful support for conceptual science learning in the early grades.

The Sensing Science through Modeling Matter (S2M2): Kindergarten Students' Development of Understanding of Matter and Its Changes project is developing and researching a technology-enriched curriculum to support learning about matter and its changes at the kindergarten level.

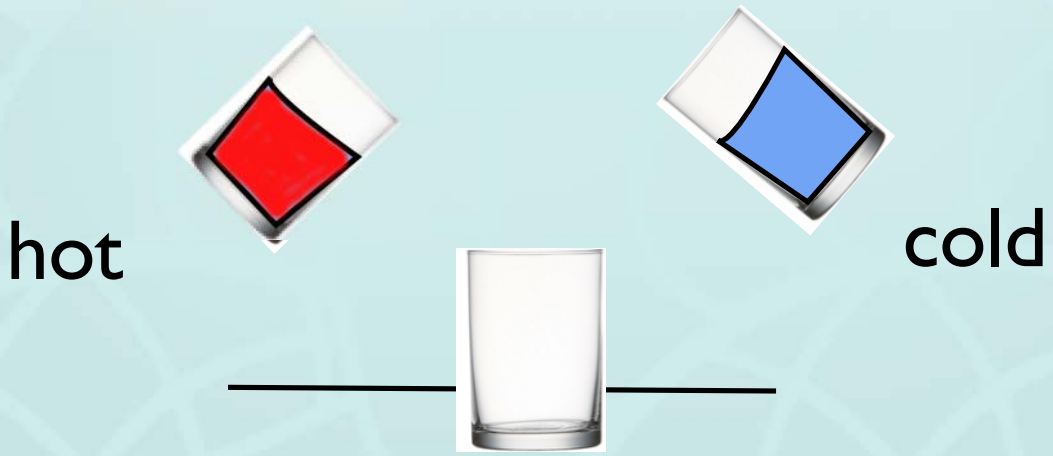
We hope that creating a curiosity for science in the early grades is a strong foundation for later STEM learning.

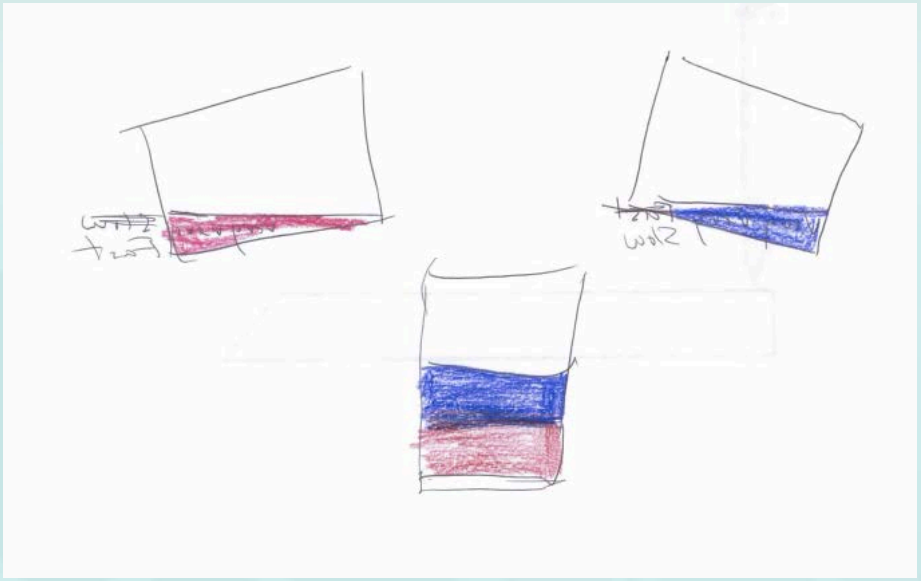
Student Preconceptions

Why Sensing Science Through Modeling Matter?

Making Nature Visible
Making Thinking Visible
Making the Invisible Visible
Improving Children's Initial Mindset

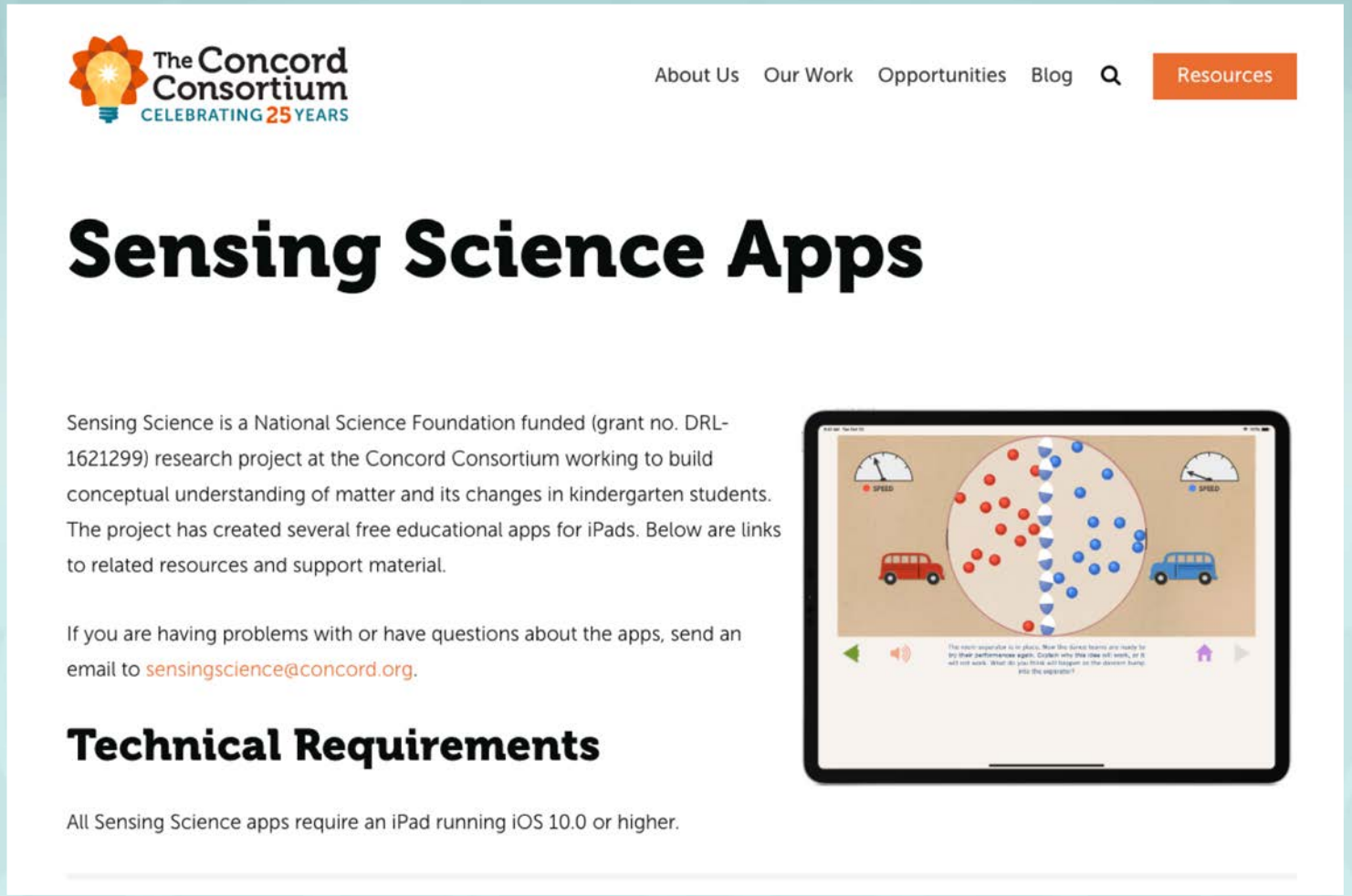
"Tell me about the temperature of the water after I pour all of the hot water and cold water into the glass on the table?"





Sensing Science Activities

Sensing Science Apps



S2M2 Activities

Thermoscope

Provides a simplified visualization of particle movement that makes the temperature differences between two materials visible.

- Thermoscope in the App Store
- Download Lesson Plan (for use with probes)
- Download Lesson Plan (for use without probes)

Land of Bump

An animated story that introduces the motion of particles related to temperature and energy transfer in an accessible, interactive way.

- Land of Bump in the App Store
- Download Lesson Plan

Particle Modeler

A playground for experimenting with the building blocks of matter.

- Particle Modeler in the App Store
- Download Lesson Plan

Thermonator

An engaging and educational app designed to help users see their own theories about how states of matter change from solids to liquids to gases.

- Thermonator in the App Store
- Download Lesson Plan
- Tutorial Video

Flying Zippies

A whimsical online story designed to teach about particles changing states when the ambient air is heated.

- Flying Zippies in the App Store
- Download Lesson Plan

Particle Patty

A playful video animation that demonstrates the role of particle motion in solids, liquids, and gases.

- Particle Patty in the App Store
- Download Lesson Plan

https://concord.org/sensing-science-apps/

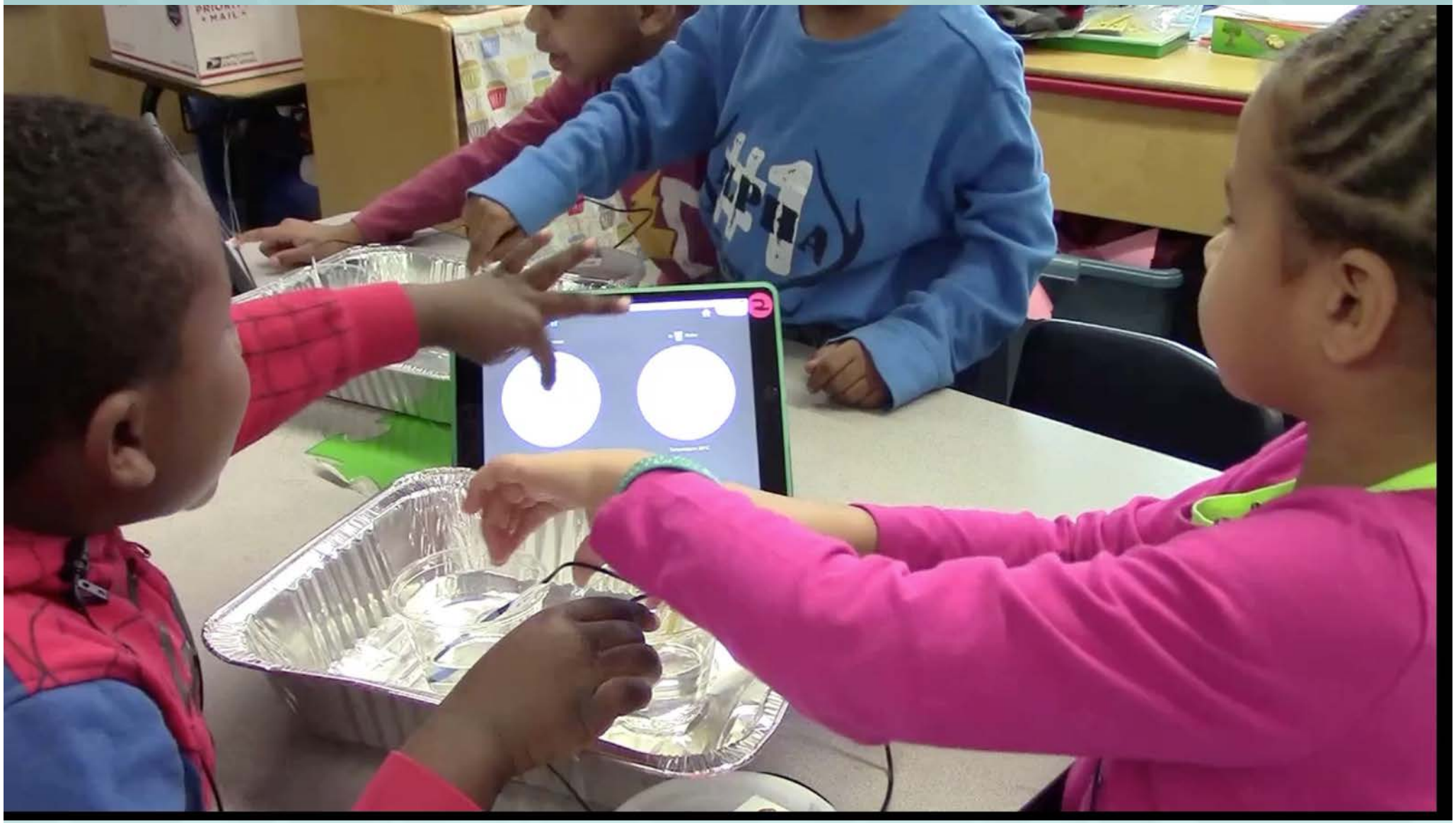
Technology

The Thermoscope

Making visible the invisible

https://thermoscope.concord.org

The Thermoscope



https://thermoscope.concord.org

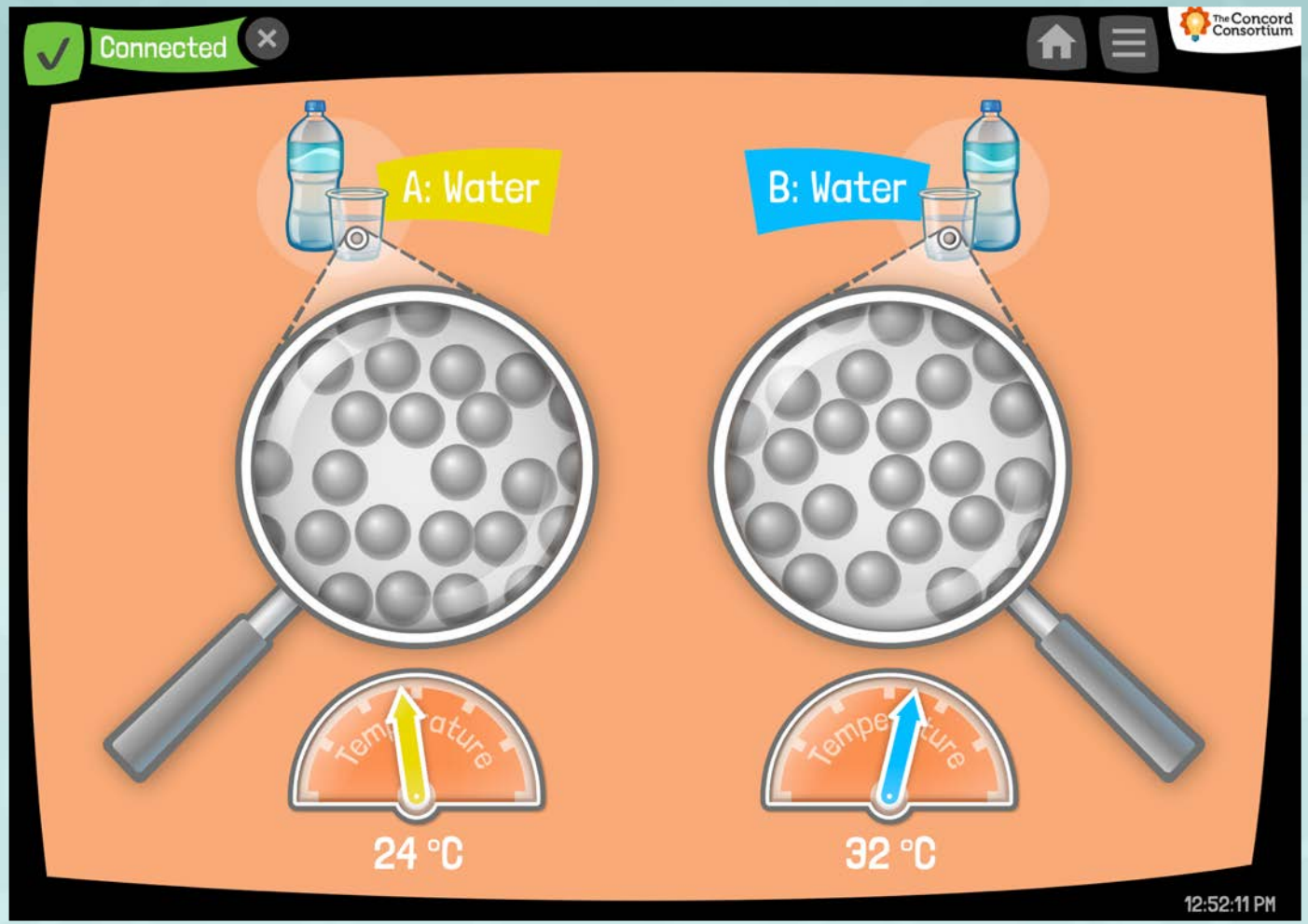
The Thermoscope

Making visible the invisible

https://thermoscope.concord.org

The Thermoscope

Temperatures of Different States



https://thermoscope.concord.org

Thermoscope in the Classroom

Odin (blue shirt): Oh, it moved again!
Girl (off camera): Now that one should be going faster.
(00:06) Teacher: And what water is that?
(00:11) Kelly (pink hair tie): That was the one was slower before.
(00:13) Teacher: That was the one that was slower before? So it changed?
(00:14) Kelly: Because we put them back where they were.
(00:18) Teacher: So which one is A [probe] right now? What water is it?
(00:20) Kelly: That one [touches cold water cup].
(00:22) Teacher: The hot water?
(00:23) Kelly: **Cold.**
(00:24) Teacher: Cold water. And what's happening to the particles?
(00:25) Kelly: The cold - this one is different because we -
(00:30) Teacher: So A [probe] is right here. What's happening to the particles on A?
(00:32) Odin**: Getting slower.**
(00:33) Teacher: They're getting slower, right? And what happens to B?
(00:36) Odin: They're getting faster.
(00:37) Teacher: Why do you think?
(00:40) Odin: Because they're [inaudible].
(00:42) Teacher: Because they're different temperature waters?
(00:44) Odin: [Nods head yes]
(00:45) Teacher: What do you think is going to happen if we just leave the water here for a while?
(00:48) Kelly: Let's wait!
(00:50) Teacher: We're going to wait it out, but what do you think is going to happen? What's your prediction?
(00:53) Kelly: I don't know.
(00:56) Odin: They'll escape. [hand over his mouth]
(00:57) Teacher: They'll escape?
(00:58) Kelly: And if maybe if we dip some in the hot water and put it in the cold [inaudible].
(01:04) Teacher: What do you think is gonna happen if you put a little of that - the cold water in the hot water? That was a good idea.
(01:09) Kelly: That one kind of go a little faster.
(01:11) Teacher: It got a little faster when you put a little hot water in the cold water.
(01:15) Odin: And that one [points], that's ones slower.
(01:17) Teacher: Wow, that's so interesting. Why do you think it went a little faster when you put a little hot water in there?
(01:22) Kelly: I don't know.
(01:23) Teacher: You don't know?
(01:24) Kelly: **Maybe it's because they both are separate from each other but then since, since they both are in the same thing, um, they're both kind of doing the same thing.**
(01:39) Teacher: Ah hum. What do you think is going to happen, Nola?
(01:44) Nola: If I put this in this [dips fingers in cold and shakes into hot]?
(01:45) Teacher: Yeah, what do you think is gonna happen to the particles if you put a little cold water in the hot water?
(01:49) Nola: those are going kind of faster!
(01:51) Teacher: So it's going a little more faster now that you put some hot water in?
(01:55) Kelly (off camera): Maybe if I dipped some of the cold water in the hot water and then put it back.
(02:01) Kelly: That one's going faster [points to Thermoscope].

The Thermoscope

Changing Phase

https://thermoscope.concord.org

The Thermoscope

Mixing

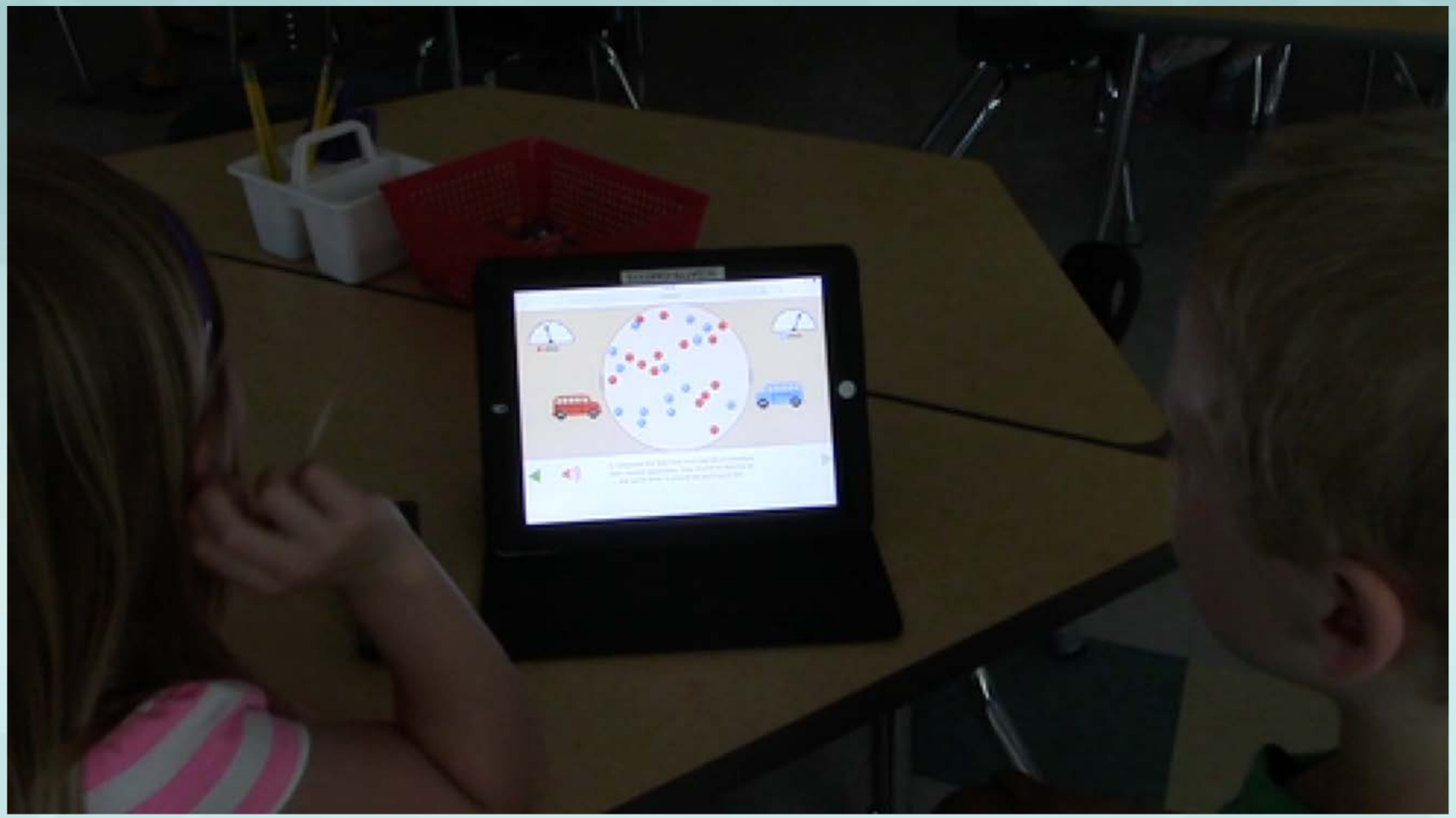
https://thermoscope.concord.org

www.FableVisionStudios.com

@FVStudioBoston

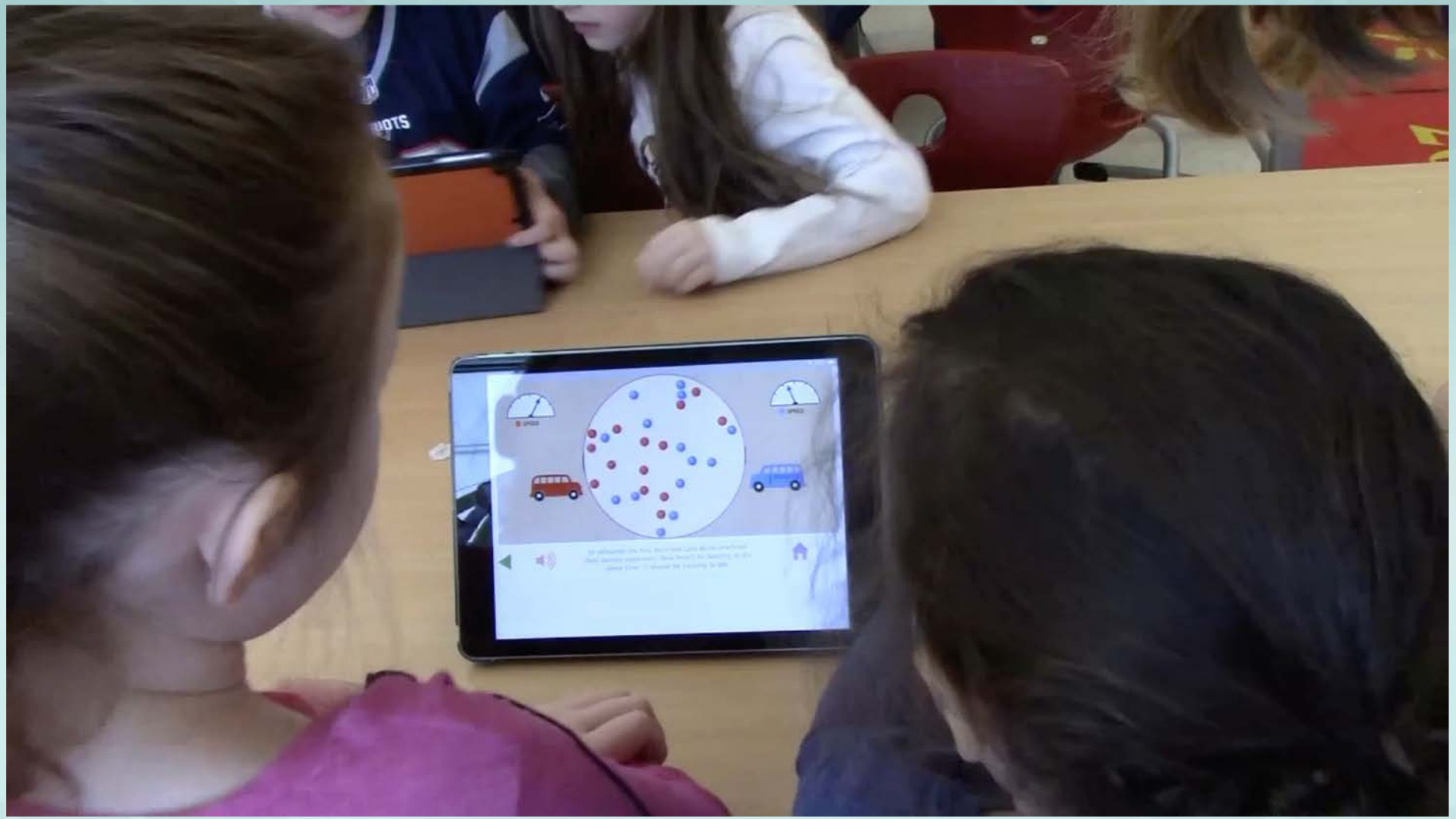
https://lob.concord.org

Land of Bump



We believe that in Sensing Science we were creating a basis for children to understand that all substances are made up of the same type of particles that increase speed when heated.

Land of Bump

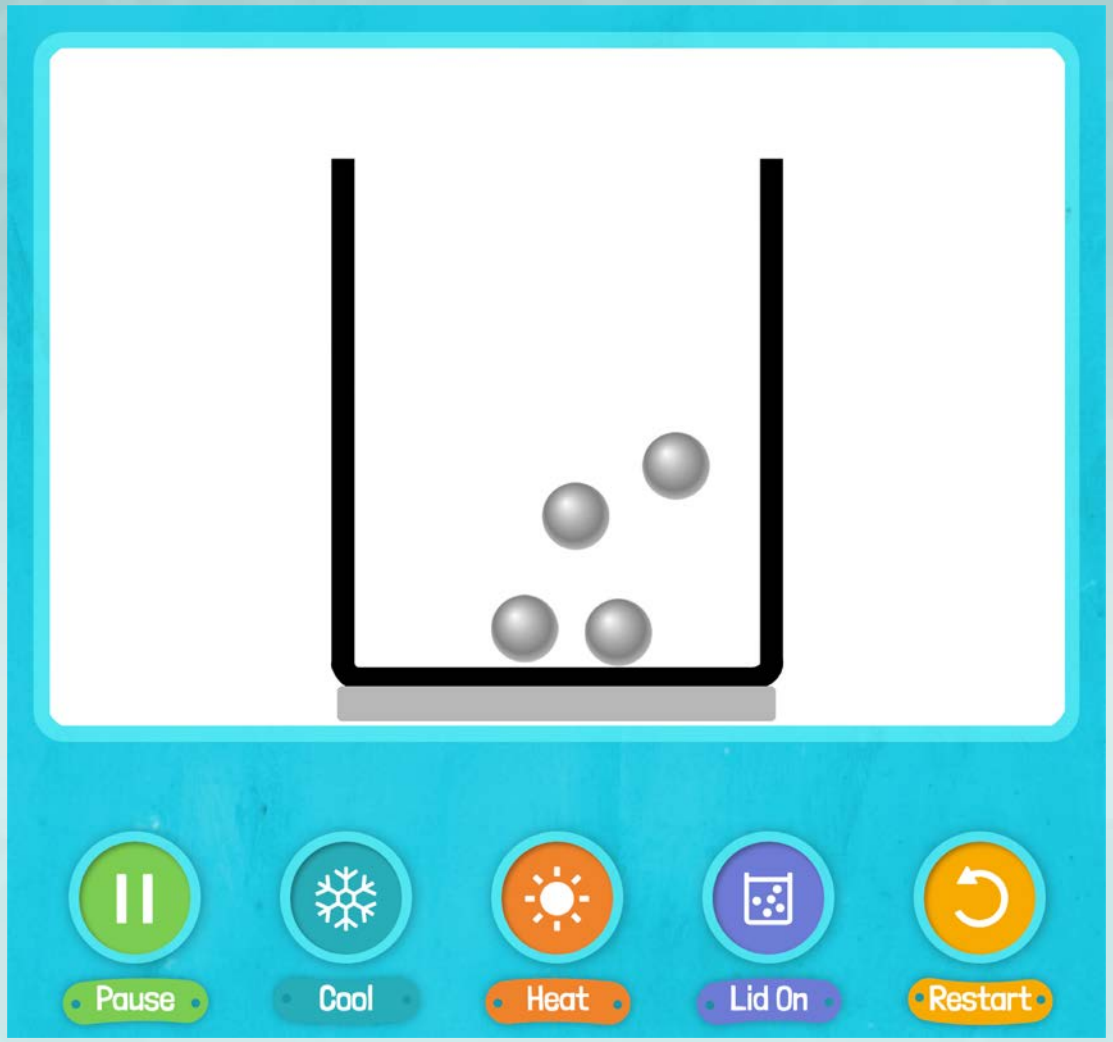


We posit that once the child understands the bumping mechanism of transfer of heat, we can help the child differentiate states of matter based on the bonds among particles (solid, liquid, gas), along a continuum of change.

Thermoscope & Land of Bump Connection

Interviewer: Do you remember what it looked like when we put our probe in the hot water? *Soham*: Yeah.
Interviewer: What happened? It was on the screen. We had two circles on the screen and what was in those circles? Do you remember? *Soham*: Uh, no. *Interviewer*: Little dots that moved around.
Cillian: Oh, yeah! *Soham*: Yeah!
Interviewer: And how did they move? Do you remember?
Soham: **Slowly and fast. And they're the same things in here (points to Land of Bump).**
Interviewer: So, slowly and fast. And which ones were fast and which ones were slow?
Soham & Cillian: **Blue ones were slow and the red ones were fast.**
Soham: **So, the same things (points to Land of Bump).**
Cillian: **Yeah, and every time they bump into each other they lose their, they lose, they lose how hot they are 'cause they slow down and get cooler.**

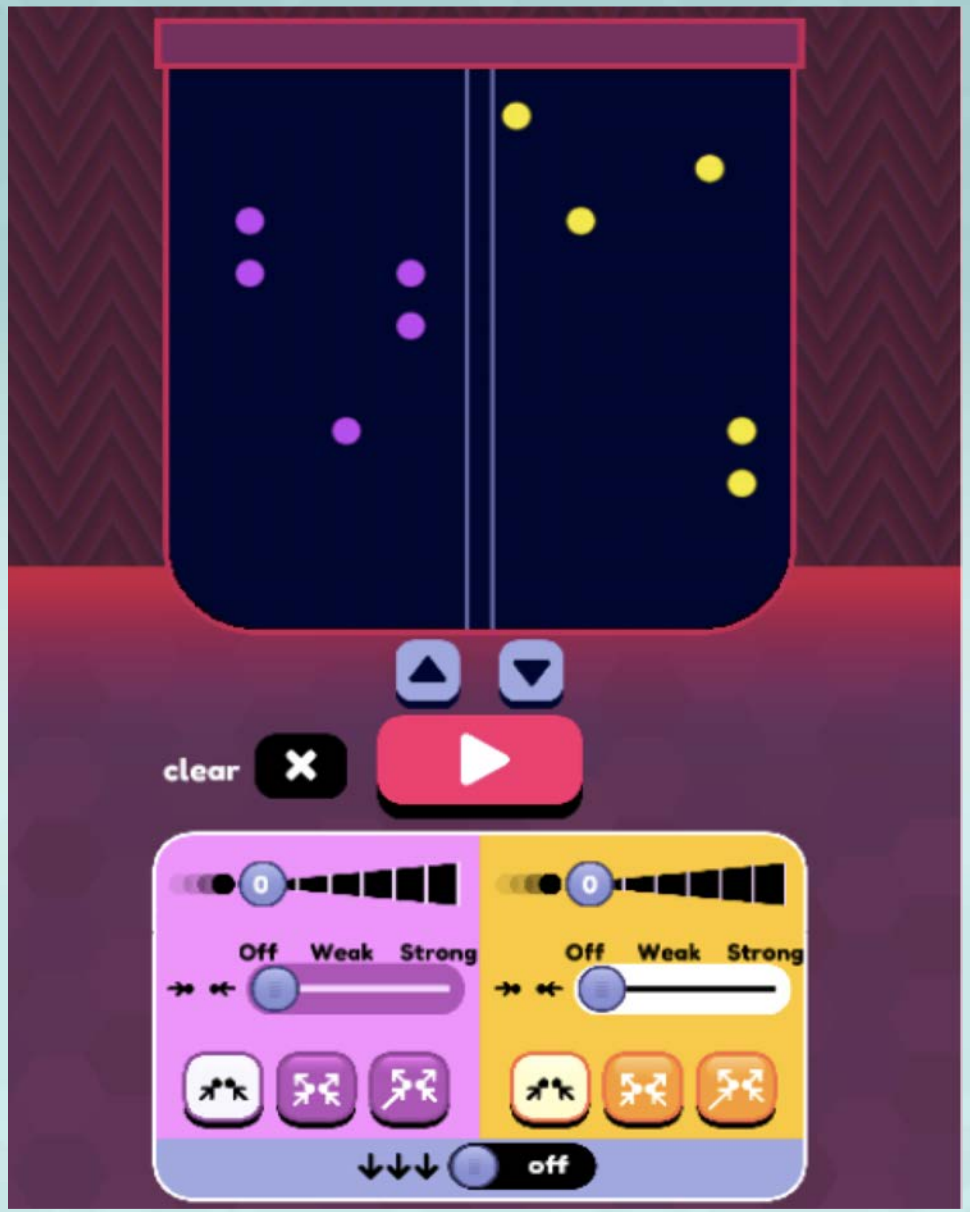
Particle Modeler



https://particlemodeler.concord.org

Particle Modeler

Thermonator



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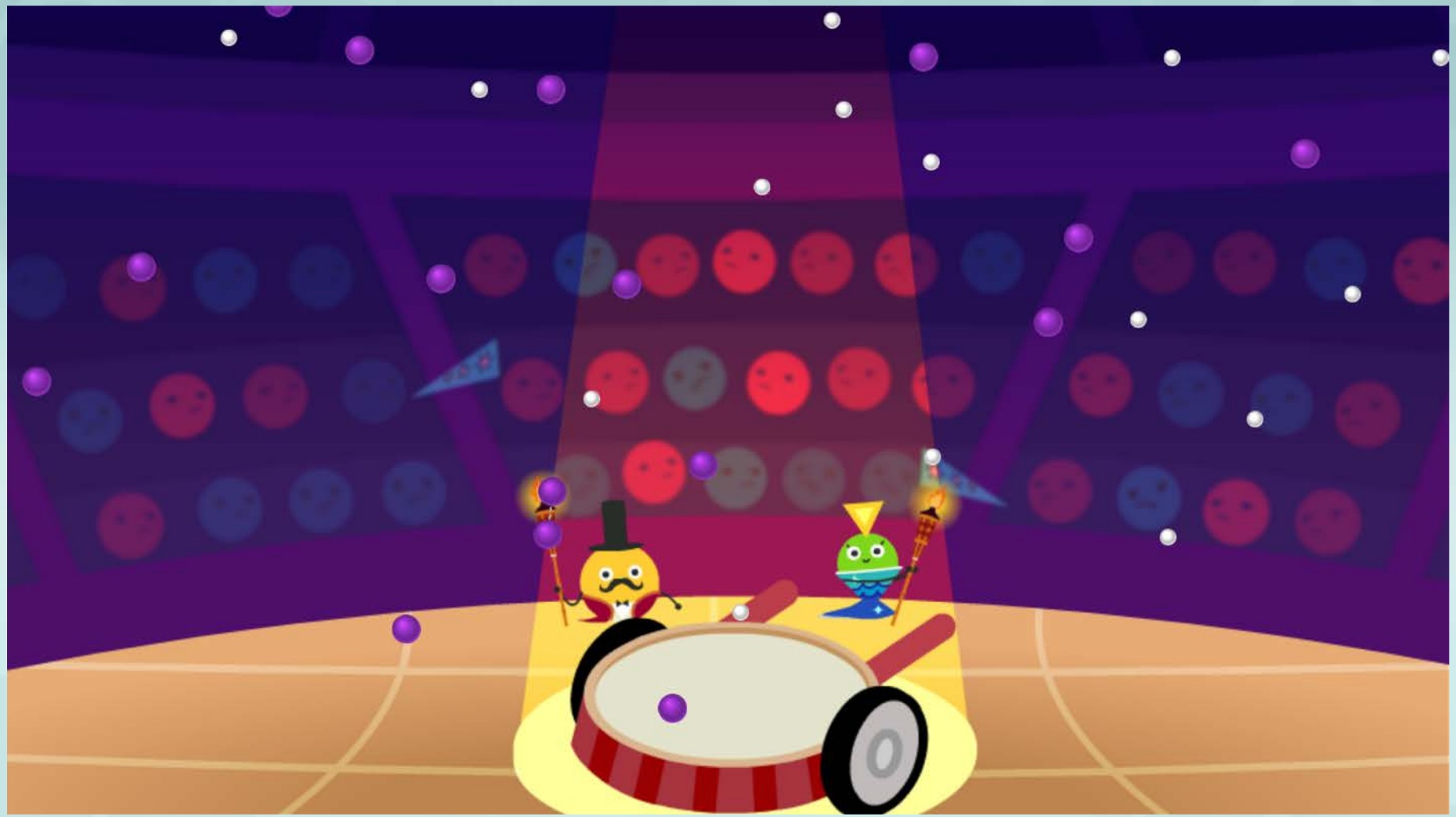
Thermonator

The Flying Zippies



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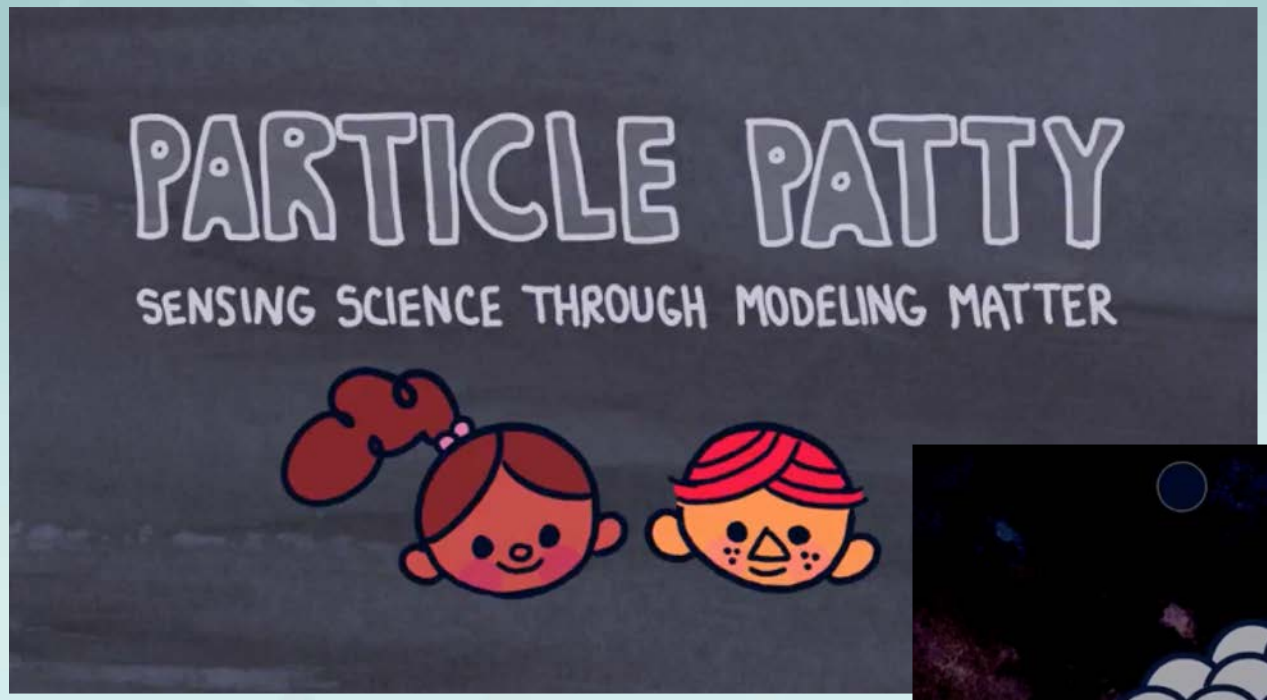
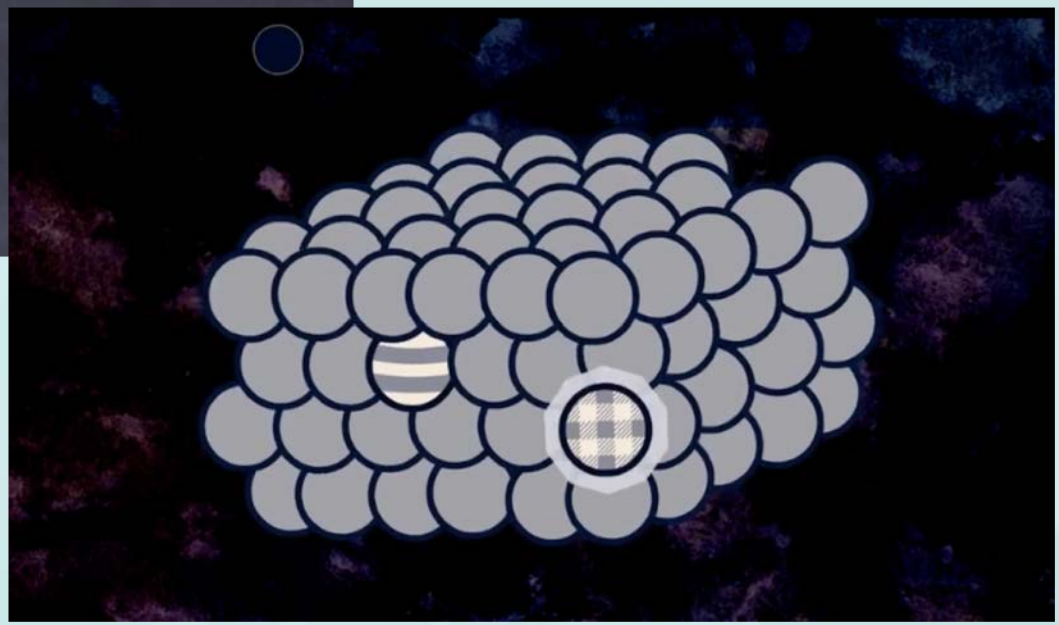
The Flying Zippies

Particle Patty





https://youtu.be/GVRTa0JopuE

Research Study

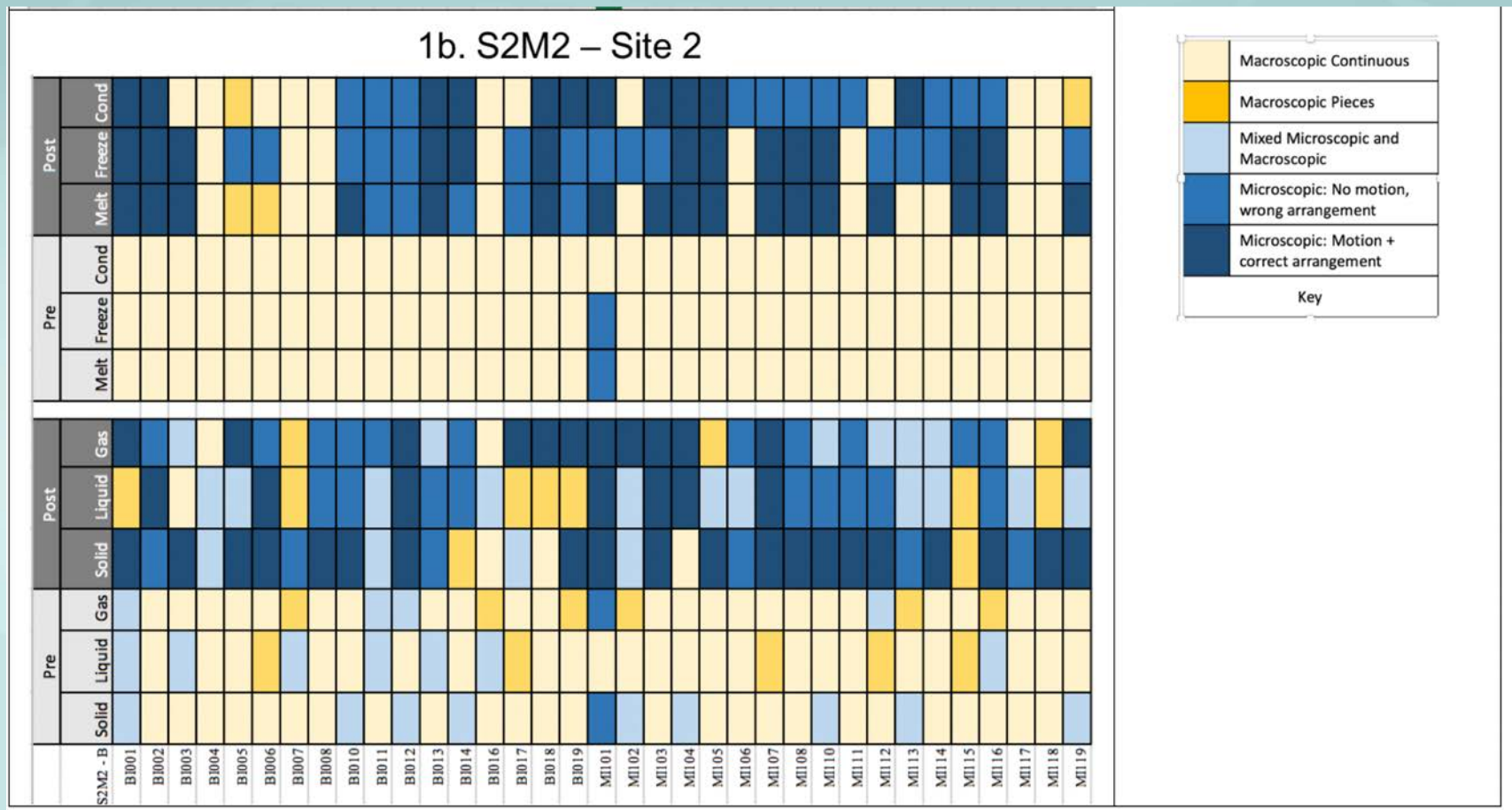
S2M2 Research Questions

1. How do kindergarteners understand and use particulate models to explain physical phenomena such as states of matter and phase changes?

2. How can the use of a modeling context and technology-based dynamic representations influence kindergarteners' ability to learn to model physical phenomena?

3. How does growth during the year relate to kindergarteners' ability to understand and use particulate models?

S2M2 Site 2 Research



Figures 1a-b. Heatmaps showing pre-post changes in S2M2-Site 1 and S2M2-Site 2 students' models. Each colored row represents a single student. Each cell in that row represents the child's model for the target phenomenon.

Newsletter Links

Sensing Science Temperature Readiness
https://concord.org/newsletter/2014-spring/sensing-science/

Land of Bump
https://concord.org/newsletter/2015-fall/land-of-bump/

Flying Zippies
https://concord.org/newsletter/2017-spring/sensing-science-modeling-matter/

Particle Modeler and Thermonator
https://concord.org/newsletter/2019-fall/children-explore-particle-world/

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