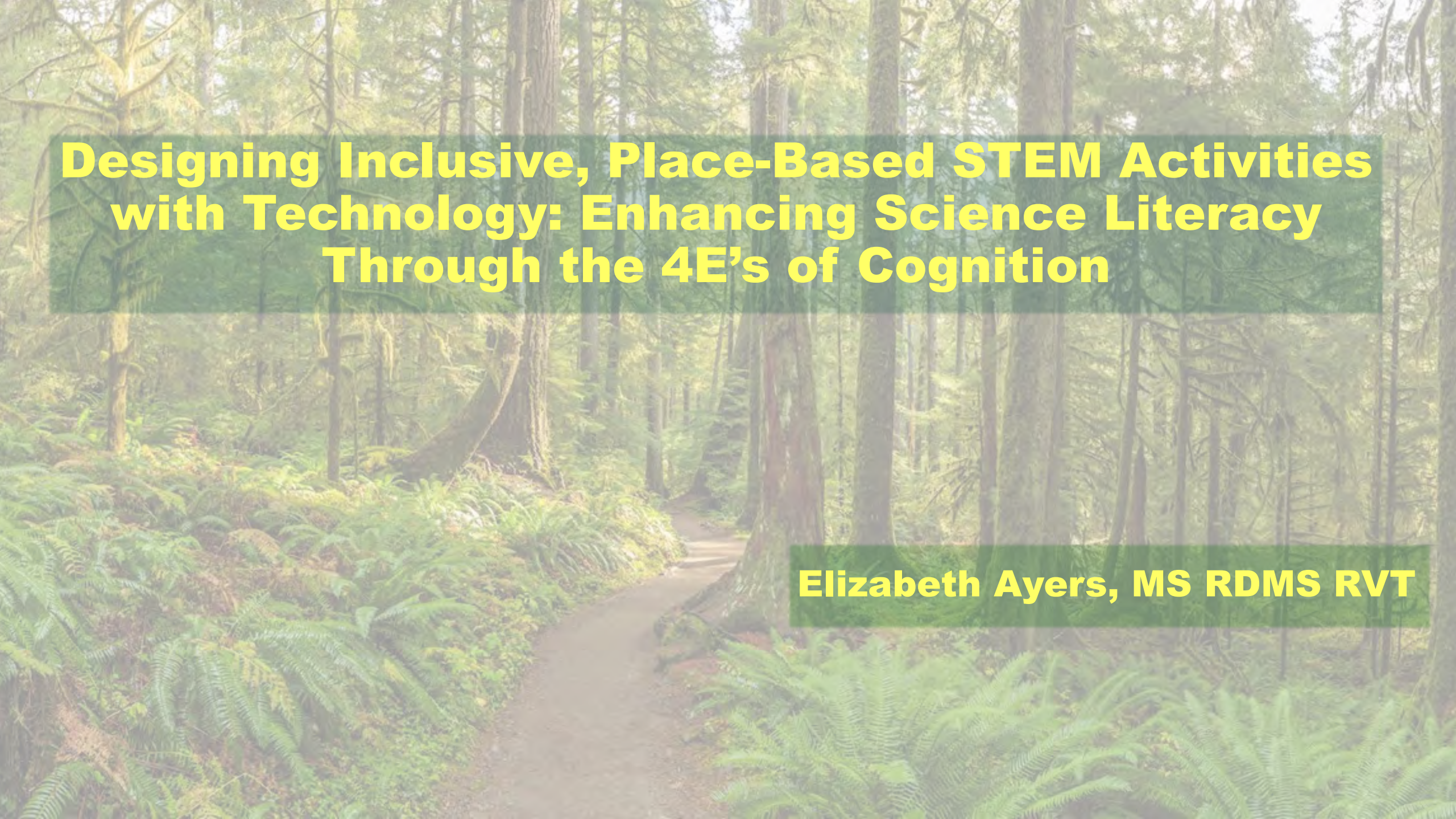

Designing Inclusive, Place-Based STEM Activities with Technology: Enhancing Science Literacy Through the 4E's of Cognition

Elizabeth Ayers, MS RDMS RVT

Agenda

- Mentimeter
- Universal Design for Learning
- 4E's of Cognition
- Seek by iNaturalist app
- Q/A
- Play time!

Liz who?

- Seattle native
- RIT/NTID instructor + sonographer /clinical instructor + mentor + advocate + more!
- Research interests: science/health literacy + UDL + increasing DHH representation in healthcare

RIT | National Technical Institute for the Deaf
Deaf Health Care and Biomedical Science Hub

Mentimeter

- www.menti.com

- Code 2245 2772
  - Cool app to engage students!

Mentimeter practice

1) Which state do you live in?

2) What topic(s) do you teach?

3) What type of setting do you teach/work in?

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Mentimeter

Which state do you live in?

19 responses

6 15

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Mentimeter

What topic(s) do you teach?

17 responses

Math and science

Chemistry

Science

Statistics and Math

Science, stem, computer science

Chemistry, biology, math

Anatomy and Physiology

I have taught math, science, and social studies

English as a Foreign Language

Life Science

Science

ChemistryBiologyEarthans Space Sciences

Sciencesciencesciences

Methods for math and stemComputers in classroom

Chemistry Biology Physics. Environmental science

3

16

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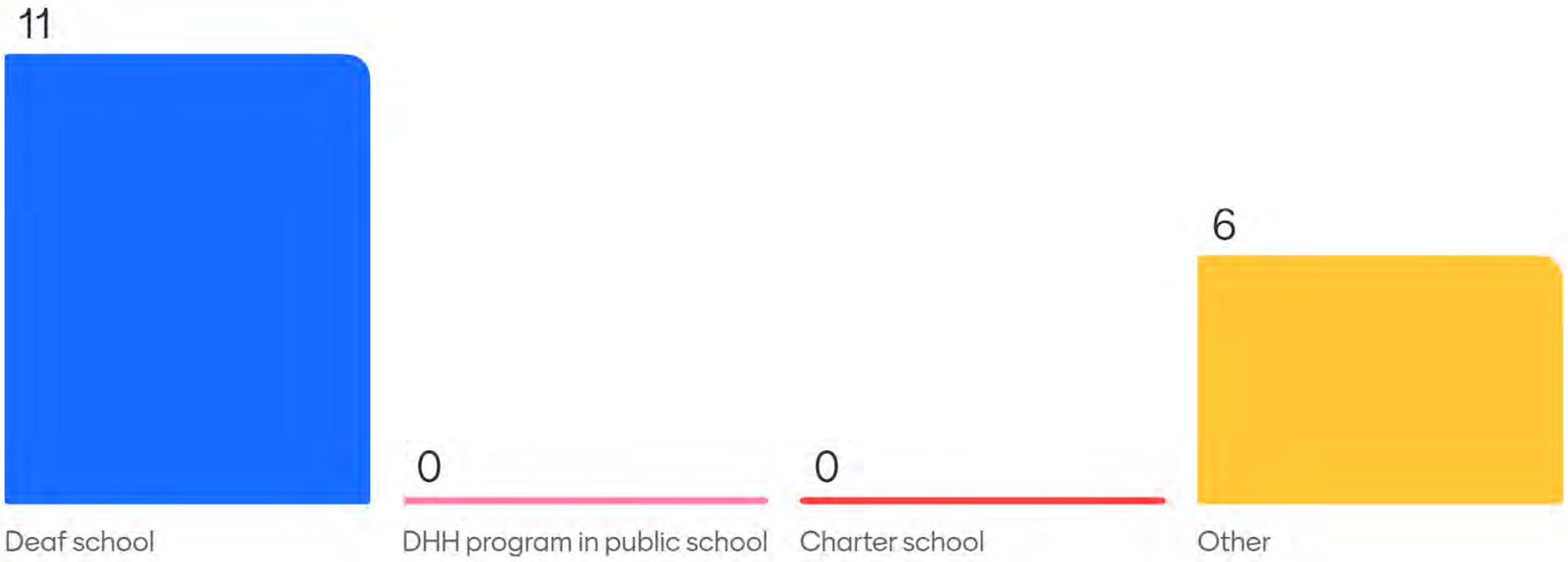
Mentimeter

What type of setting do you teach/work in?



17

Mentimeter

- In one or few words, what is your memory of STEM instruction as a student?
  - either K-12 or postsecondary

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Mentimeter

In one or few words, what is your memory of STEM instruction as a student?

22 responses

I hate math	Always fun and exciting	New	Interesting
I don't remember any STEM related activities maybe I'm too old	I love stem. Hands on experiences!	informal learning champ fun!	Awesome memories of chemistry and biology!
Most of the experiences were not hands on... Prior to the internet	Complex	Empty	overwhelming
	Classroom pets!	Slides, lab, classroom critters, internships. etc	Wish it was more hands on learning

18

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Mentimeter

In one or few words, what is your memory of STEM instruction as a student?

22 responses

Most of the experiences were not hands on... Prior to the internet

Classroom pets!

Slides, lab, classroom critters, internships. etc

Wish it was more hands on learning

No interpreter

feeding the classroom snake

Didn't have STEM

[No Title]

Learning of Science using Technology Engineering and Matthew

Taking forensic science and doing labs helped me picture myself in a science career

"Oops" during a dissection!

18

Problem: Literacy disparity

- Science literacy disparity between DHH and hearing peers (Smith & Samar, 2016)

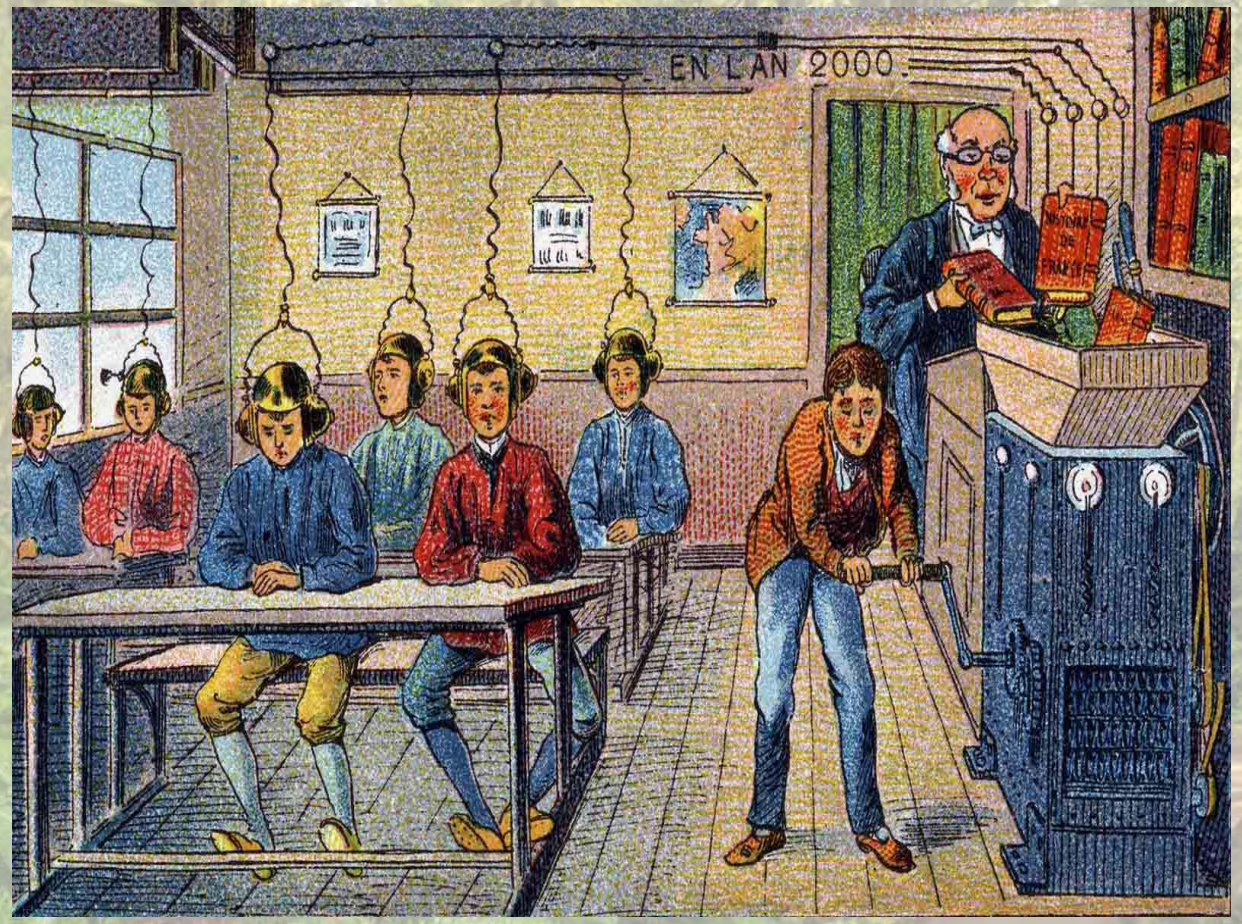
- Textbook content is primarily expository
  - Unnatural form of thinking & discourse (Martin & Miller, 1988)

- Biology textbooks contain 45-50% more new words than foreign language books! (Thonney, 2016)

“Sage on the Stage” approach

- STEM tends to be lecture dominant, instructor-centered
- Easiest form of instruction, but … how effective is it?

Student brains as vats to be filled



"At School" by Jean Marc Côté (1900)

Learning Modes

- Mentimeter: what is your best mode for learning new information?
  - Visual (graphics)
  - Aural
  - Printed text
  - Kinesthetic (movement)
  - Gestural
  - Spatial
  - Other?

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Mentimeter

What is your best mode for learning new information?

Visual

Aural

Printed text

Kinesthetic (movement)

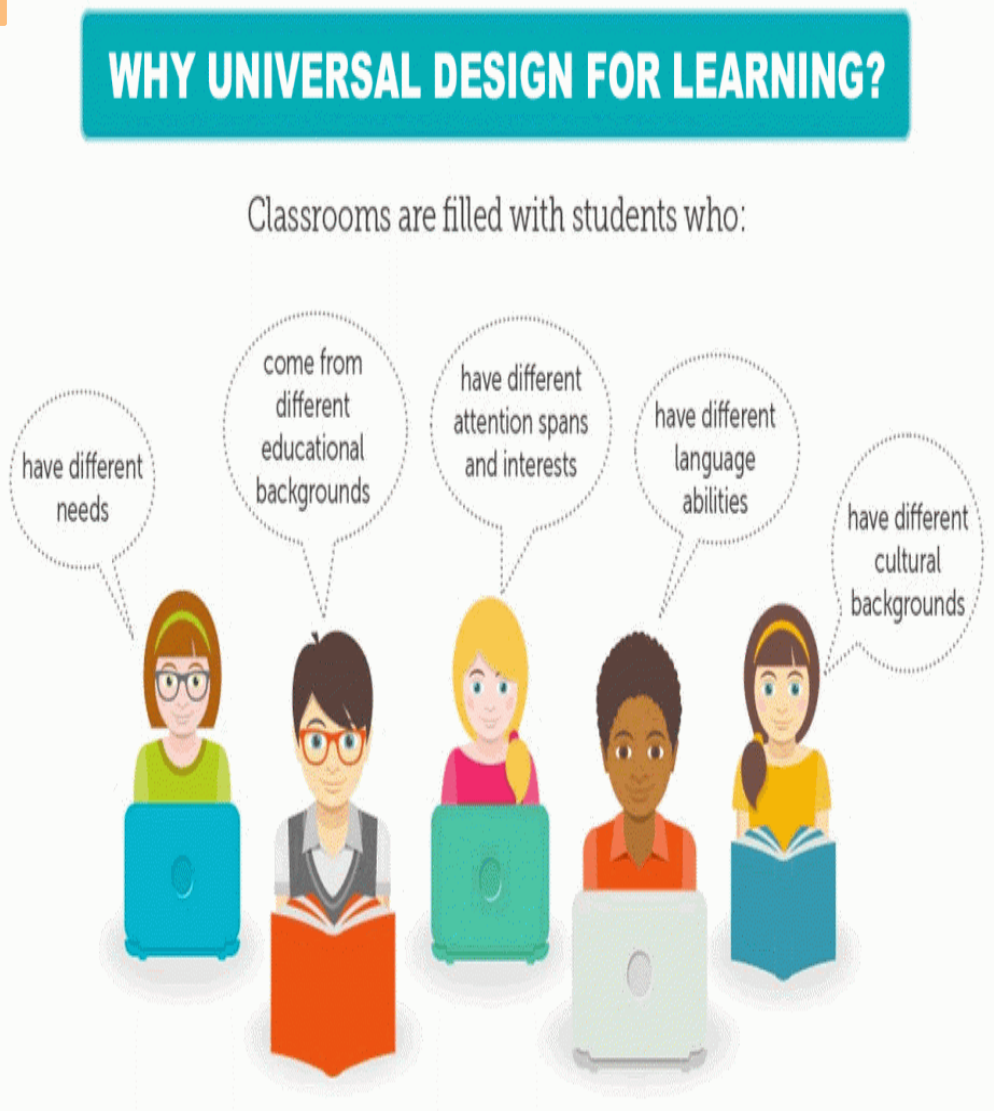
0

Gestural

Spatial (3D models)

1

17



- In addition to multiple learning modes:
  - Sociocultural considerations
    - Refugees/immigrants → English Language Learners (ELL)
    - Refugees/immigrants + DHH → ELL + ASL (depends)
  - Varying literacy levels
  - DHH communication preferences
    - ASL, oral, SimCom/SEE, Cued speech, etc.
  - Intersectional identities

How incorporate multiple modes + teach content?

Multiple learning modes → UDL!

Key Questions to Consider When Planning Lessons

Think about how learners will engage with the lesson.

Does the lesson provide options that can help all learners:

- regulate their own learning?
- sustain effort and motivation?
- engage and interest all learners?

Think about how information is presented to learners.

Does the information provide options that help all learners:

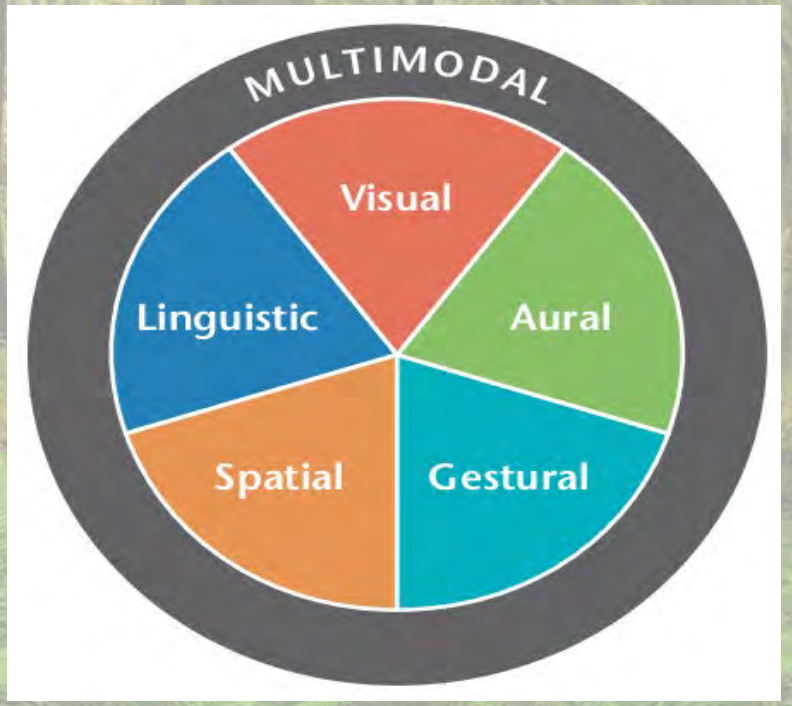
- reach higher levels of comprehension and understanding?
- understand the symbols and expressions?
- perceive what needs to be learned?

Think about how learners are expected to act strategically & express themselves.

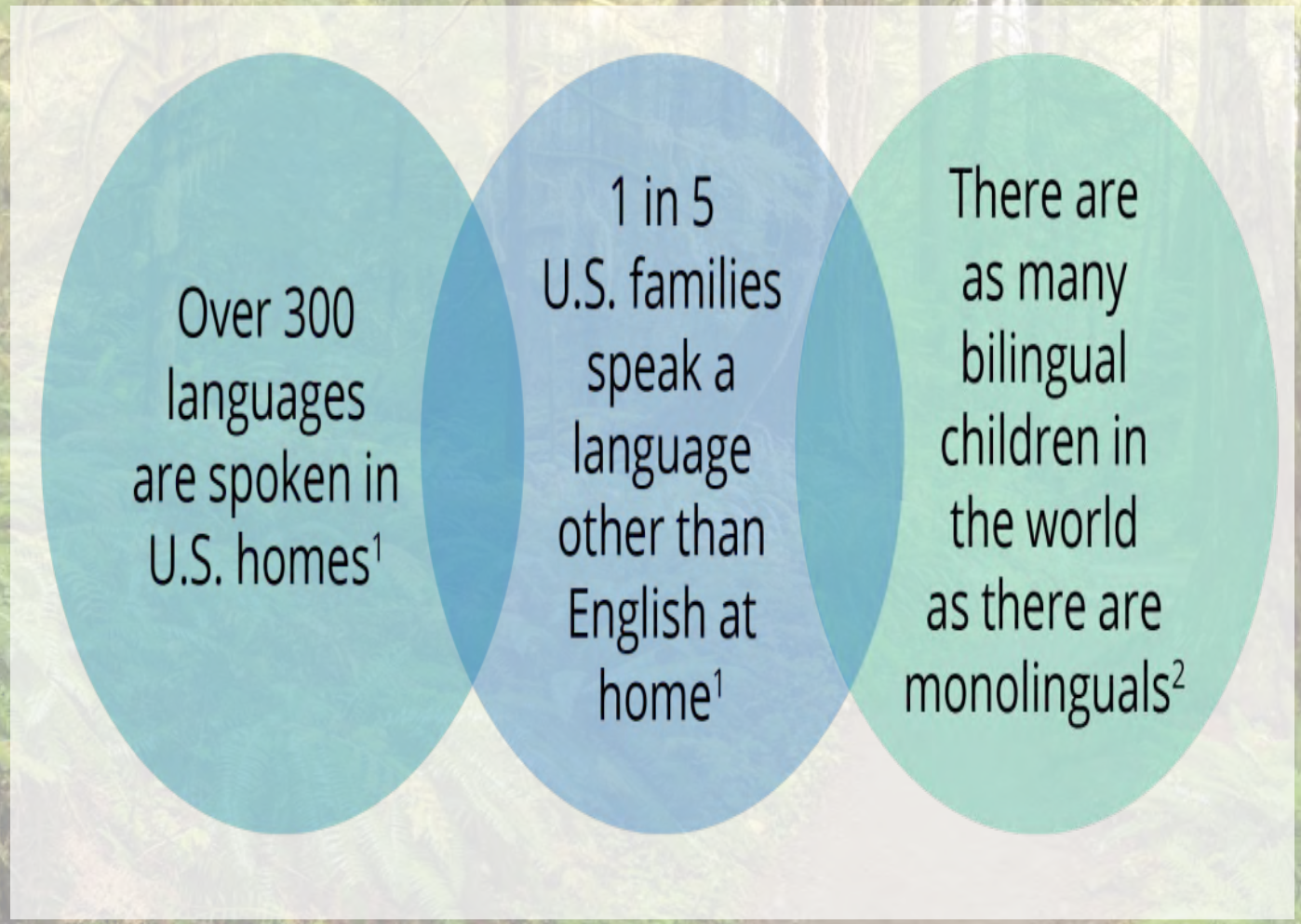
Does the activity provide options that help all learners:

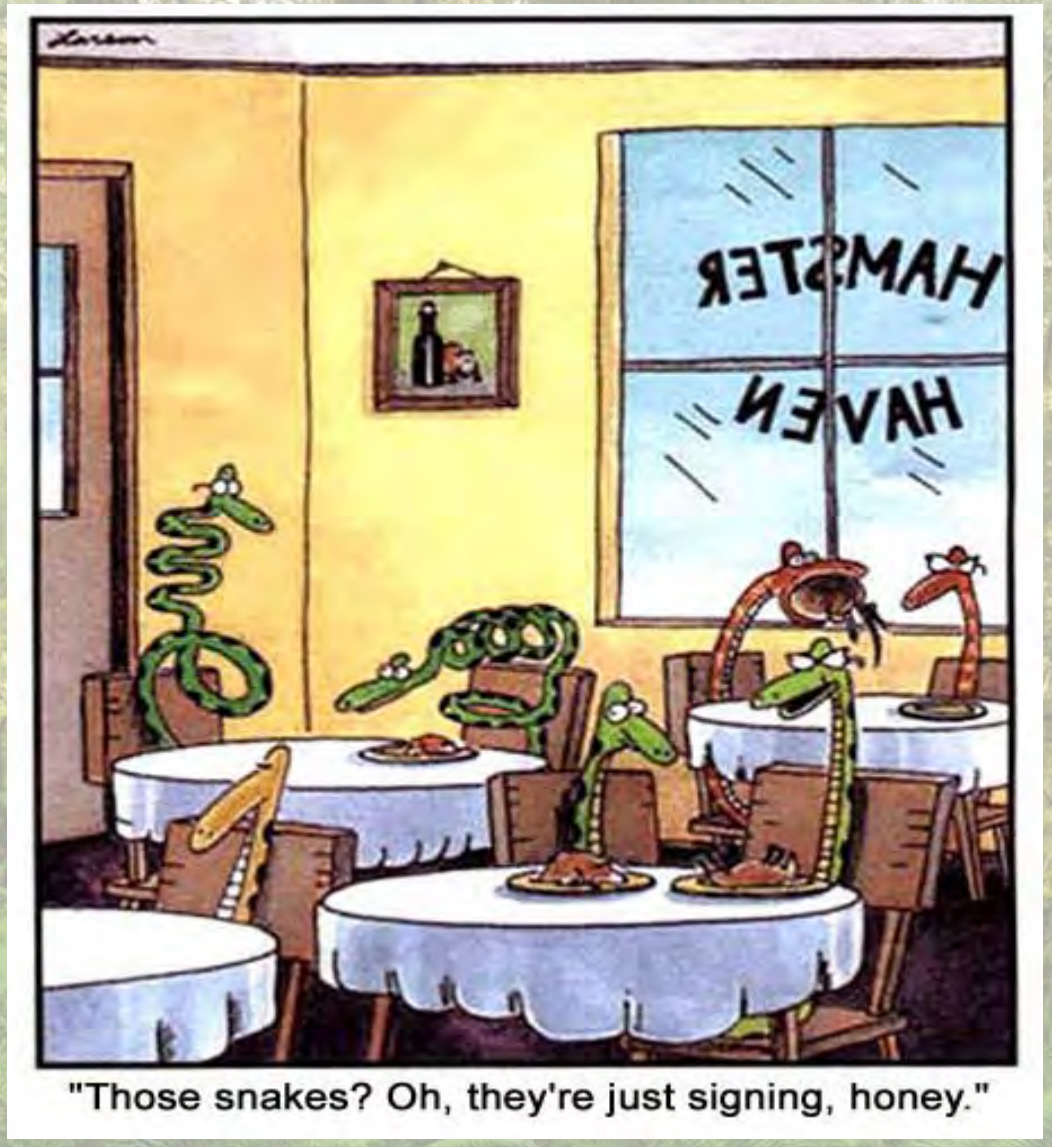
- act strategically?
- express themselves fluently?
- physically respond?

From: *Universal Design for Learning: Theory and Practice*
Available at udltheorypractice.cast.org



UDL + Multimodal → Multiliteracy!





Multimodal + Multiliteracy = Linguistic diversity!

Literacy	Multiliteracies
• Centered on language only • usually on a singular national form of language.	• Focuses on modes of representation much broader than language alone: ○ Multimodal meaning-making ○ Multimodal text design ○ A focus on cultural and linguistic diversity

Now let's shift gears …

- Mentimeter: What are the 4E's of cognition?

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Mentimeter

What are the 4E's of cognition?

13 responses

explore, explain, elaborate, evaluate

Explicit

Explore environmental

Teachers planner

Not sure

Emergency, Eyesight, Easter, Eraser

EvaluateEngage

Engage, explore, evaluate, extension

Explore, estimate, enhancement, evaluate

Enhance

Engage

Explore

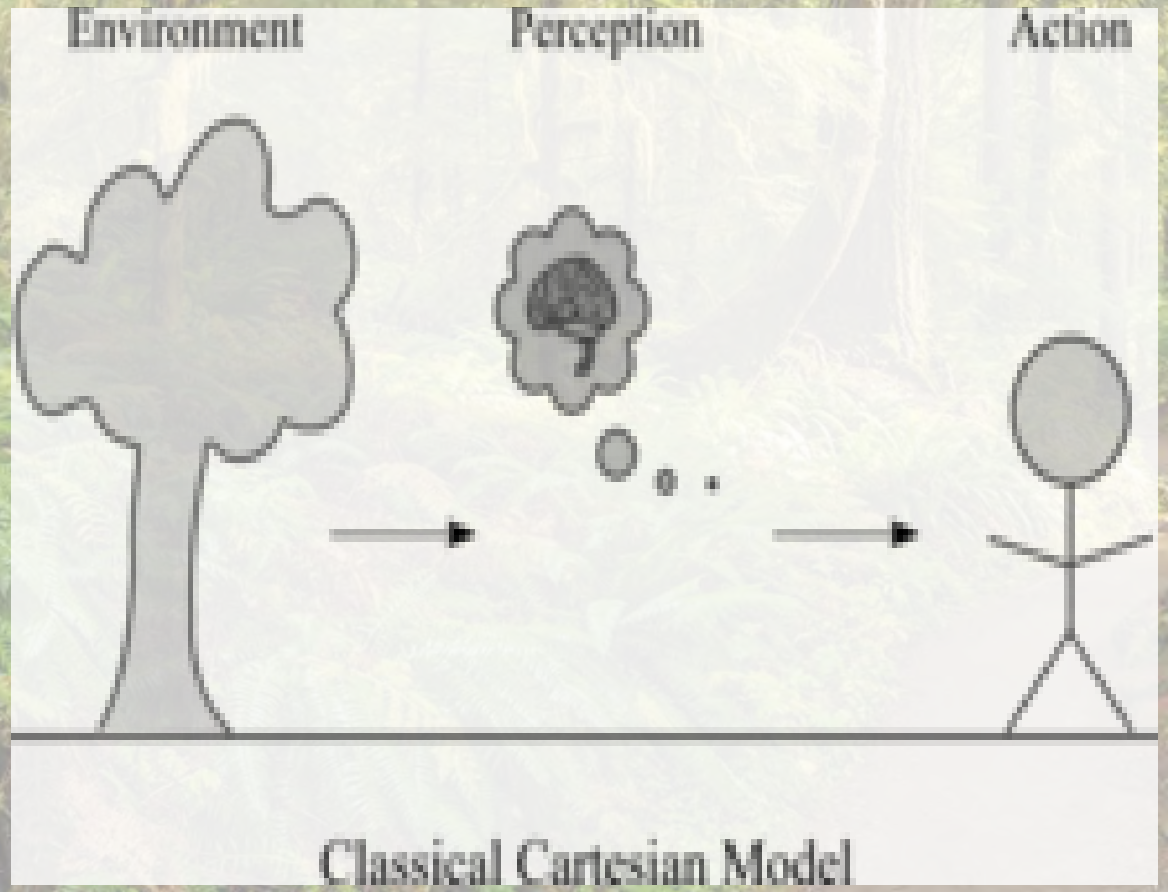
Educate, Explore, Experiment, Engage

1 12

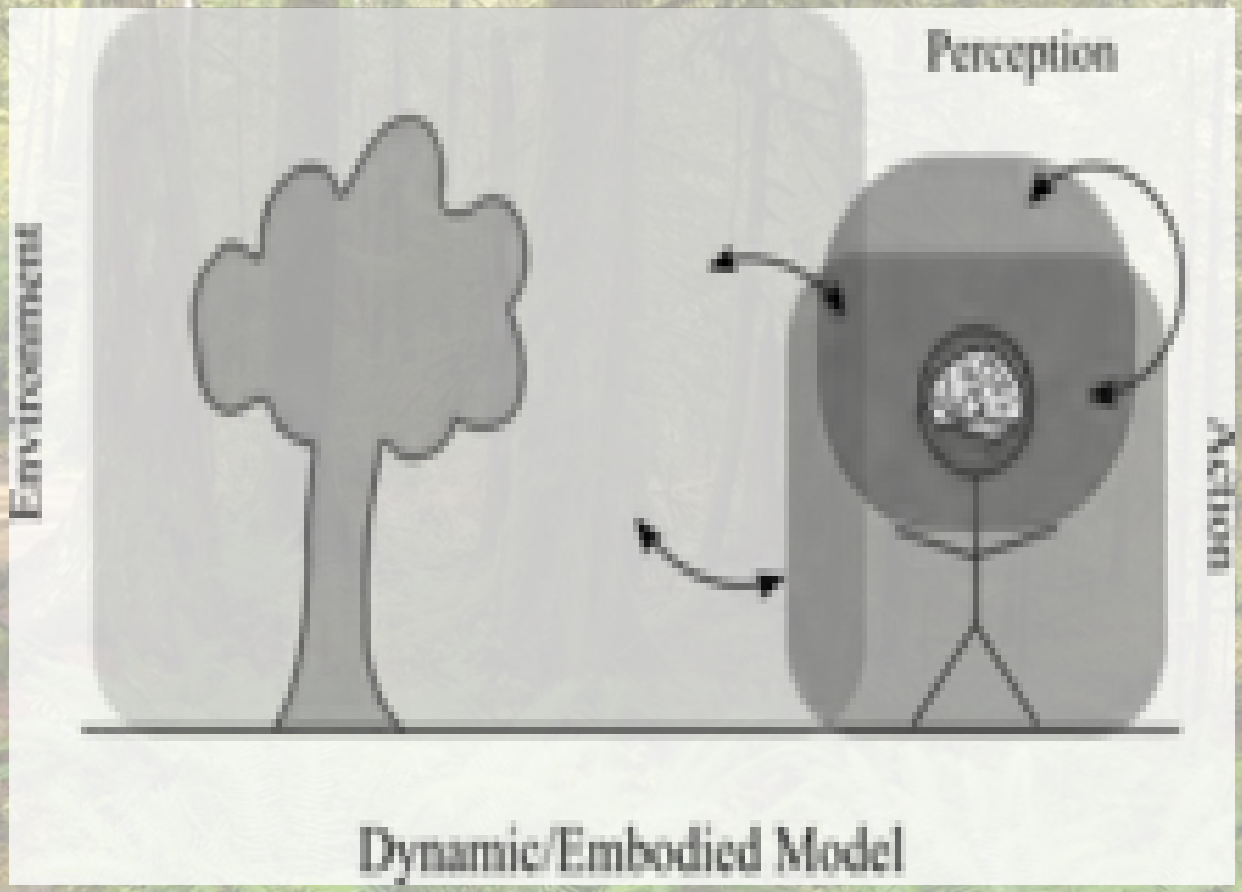
Cognition

Cartesian model:
mind separate from body

Embodied:
mind connected with body

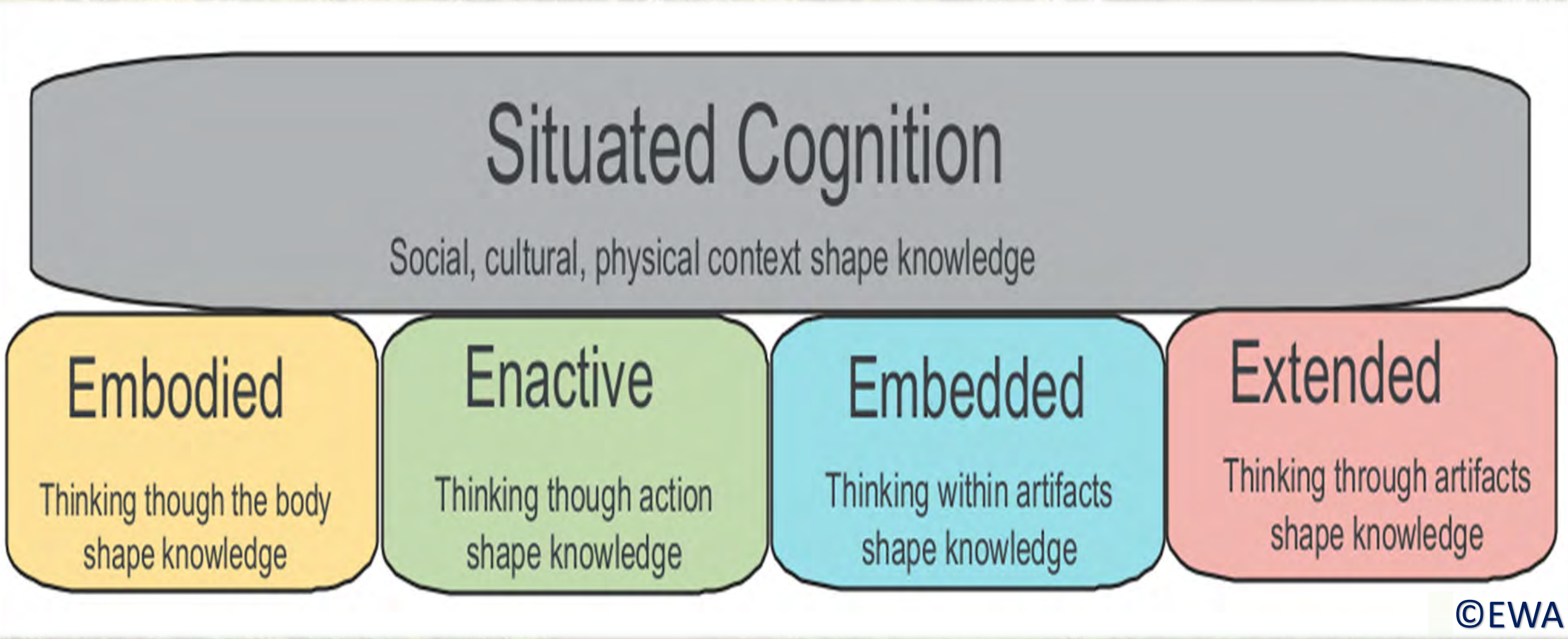


Classical Cartesian Model



Dynamic/Embodied Model

4E's of Cognition



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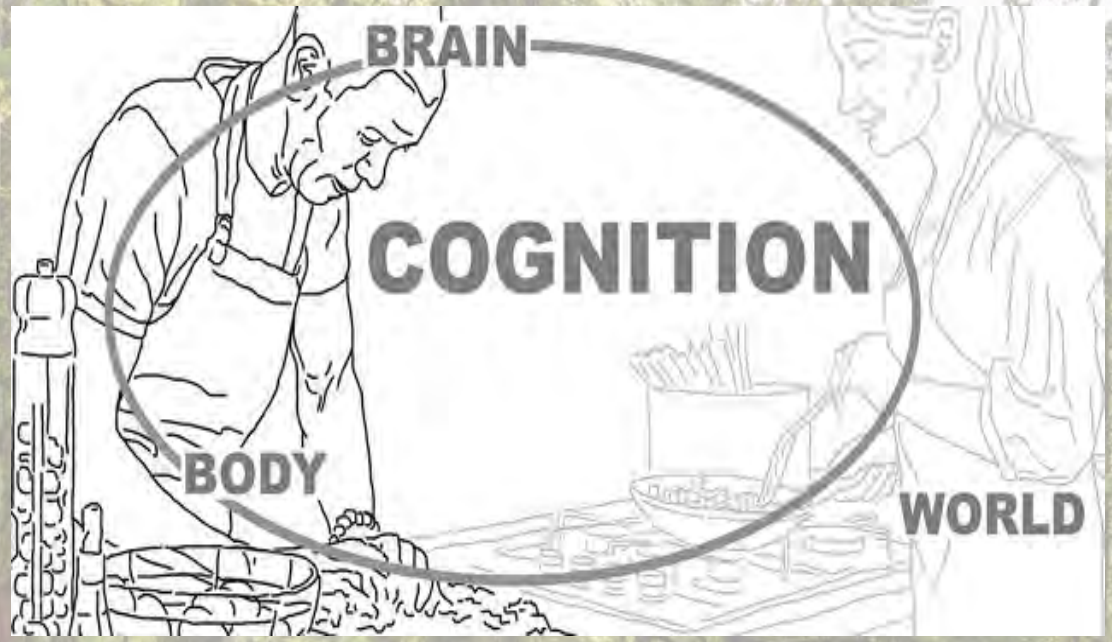
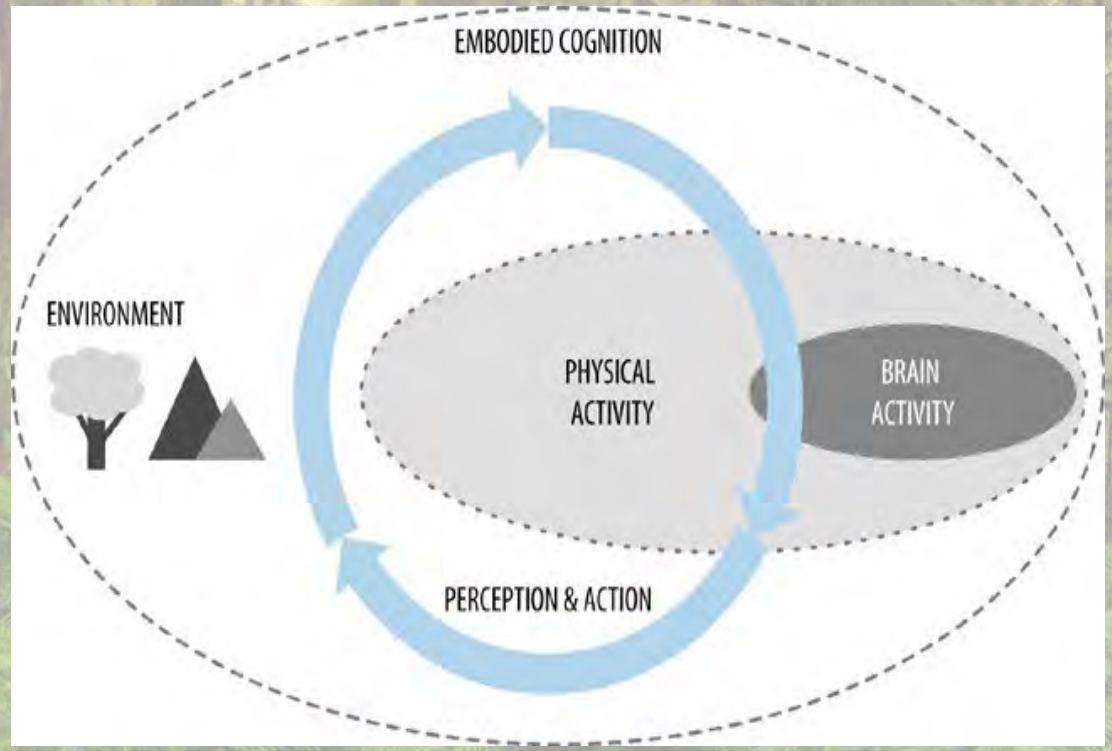
Embodied Cognition

Embodied

Thinking though the body shape knowledge



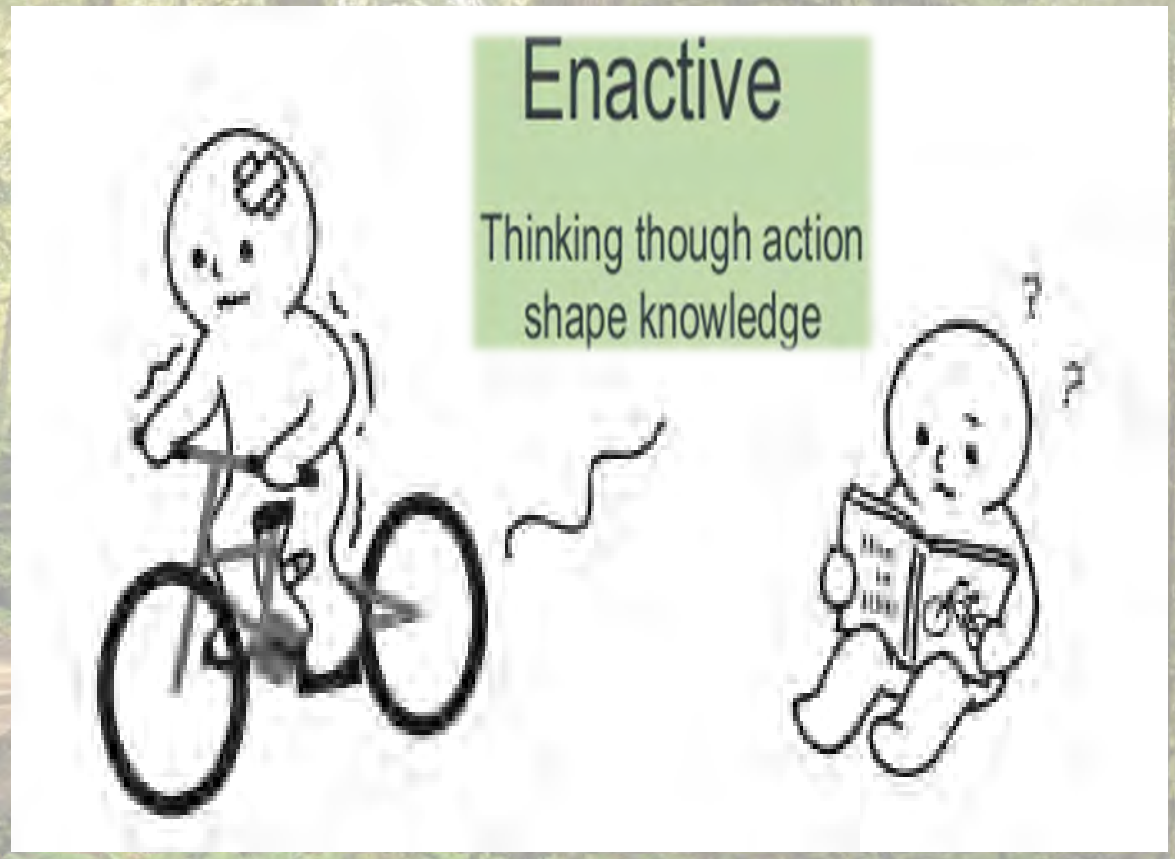


- Mind + body + environment = perception-action feedback

Enactive Cognition

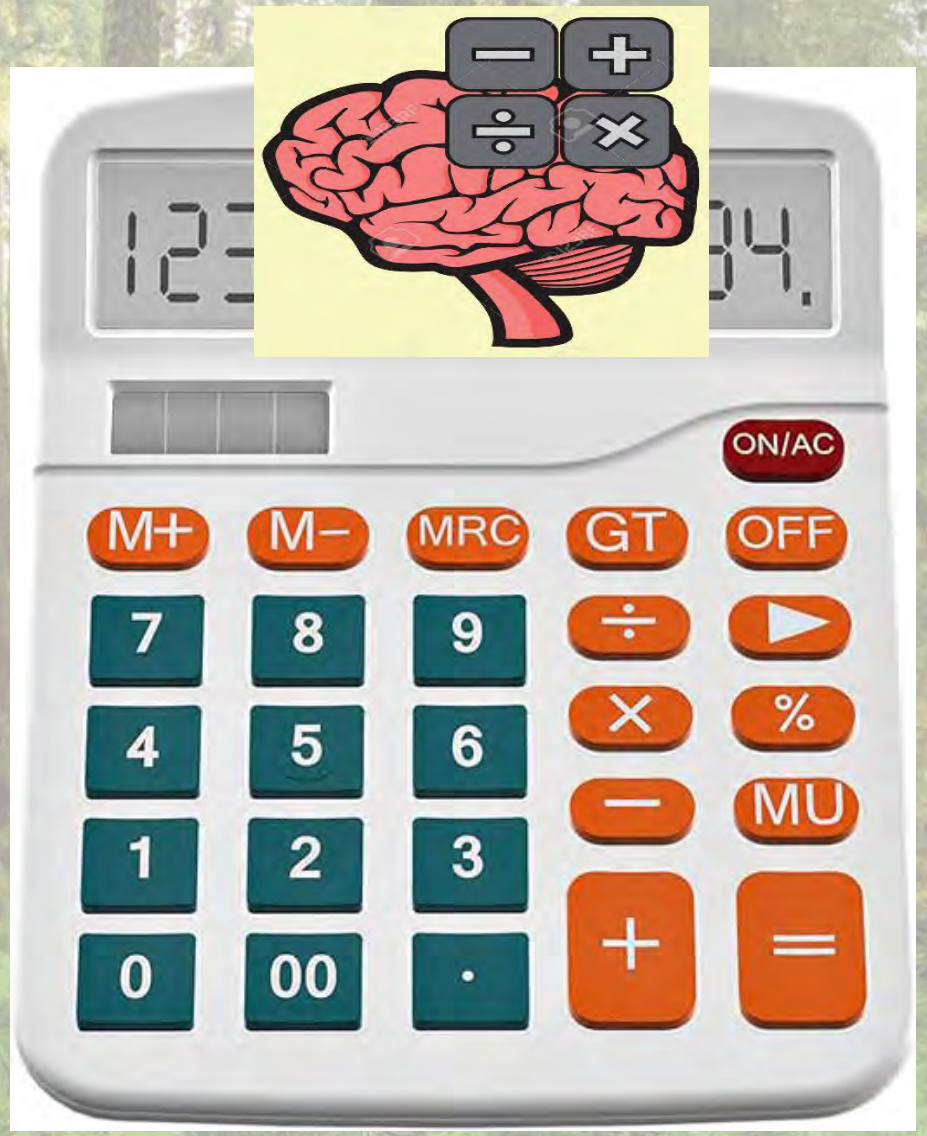
- Powder-asaurus or Stuck-asaurus?
  - https://youtu.be/x3Pkadgw0aQ?si=q-5bo2f8QhqWNEIT

- Active vs. passive learning: Is it possible to learn how to ride a bike (or snowboard) from instruction manuals/videos only?



Embedded Cognition

- Cognition influenced by environment
- Tools reduce cognitive load
  - Calculator for long division problems
- Environment shapes planning
  - Grocery store: map shopping path based on store layout

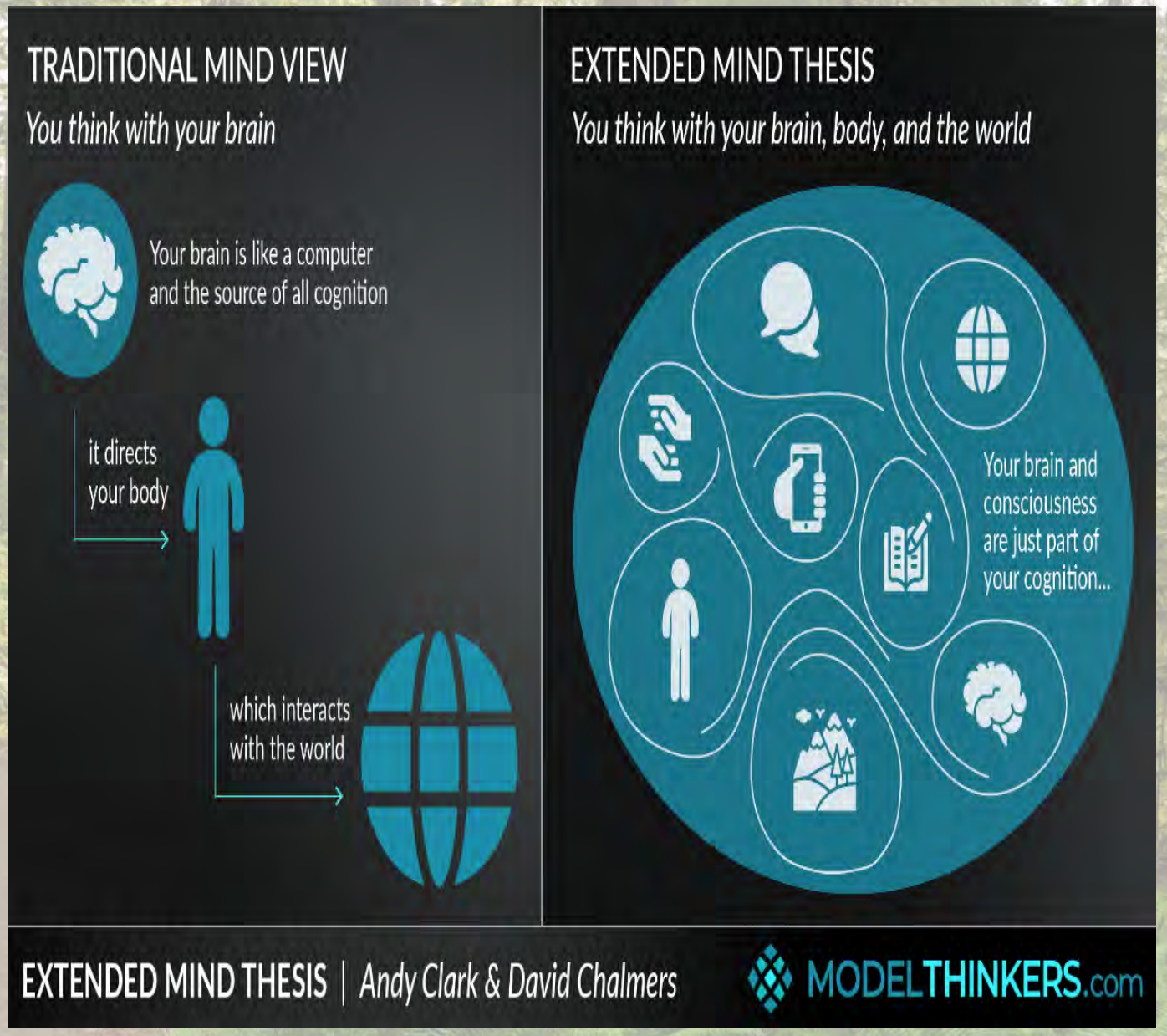


Embedded

Thinking within artifacts shape knowledge

Extended Cognition

- "Where does the mind stop and the rest of the world begin?"
  - Clark & Chalmers (1998)
- Coupled system between mind and tool
  - Calendar for important dates
  - Address book
  - Your smartphone!



Extended

Thinking through artifacts shape knowledge

- **Mentimeter:**

Can you think of other examples of extended cognition?

Extended

Thinking through artifacts shape knowledge

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Mentimeter

Can you think of other examples of extended cognition?

10 responses

gps

My car... Don't go anywhere without it

apps

Boron's a moron. He always breaks the rules.

Chatgpt

Anchor charts?

Google

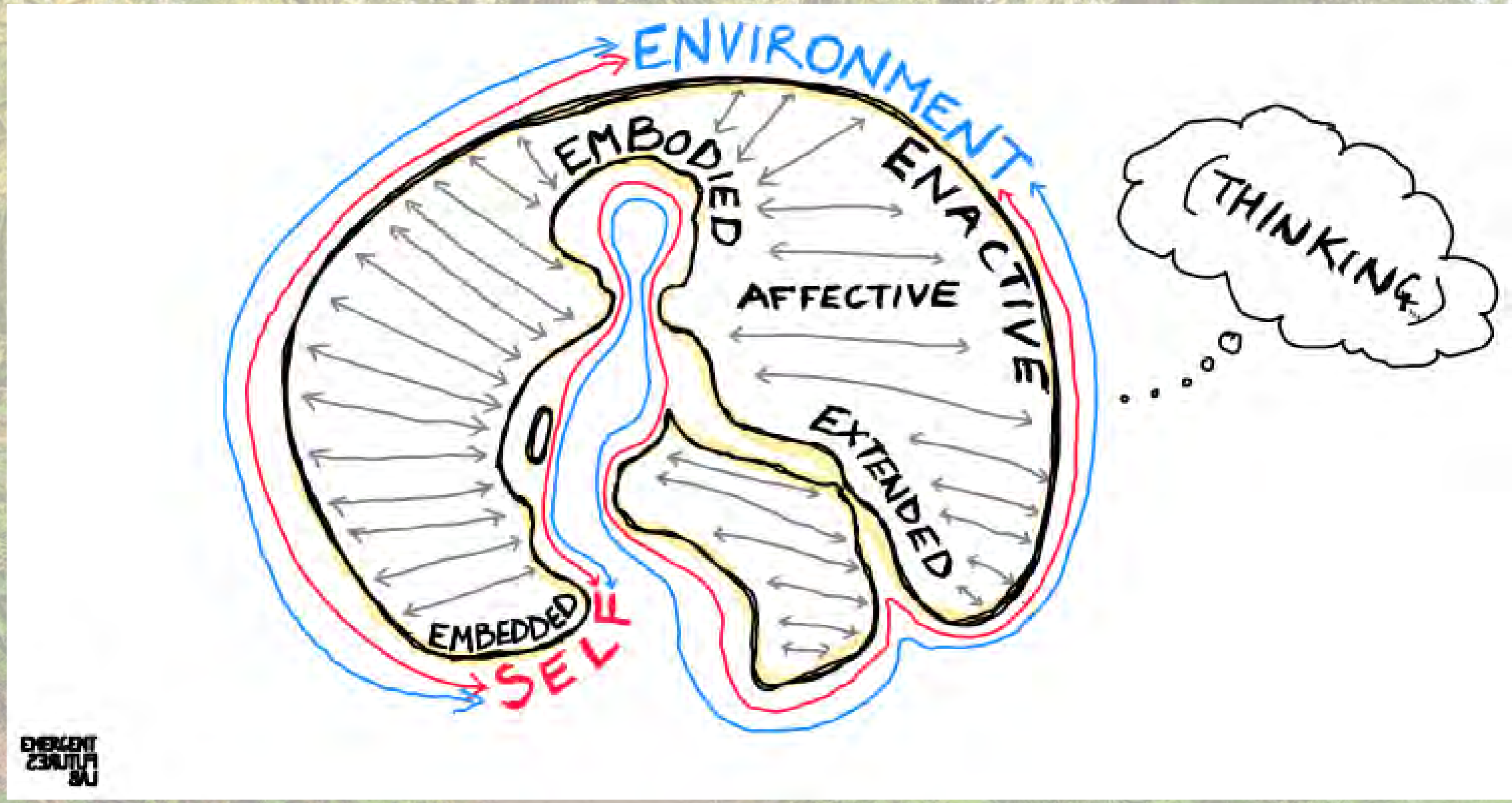
Themometer, Barometer

Laptop, GPS,

Cozi planner

10

In a nutshell... 4E cognition



Seek by iNaturalist app

- Citizen science = community + scientists
  - *eBird* – 5 million observations by community members monthly!

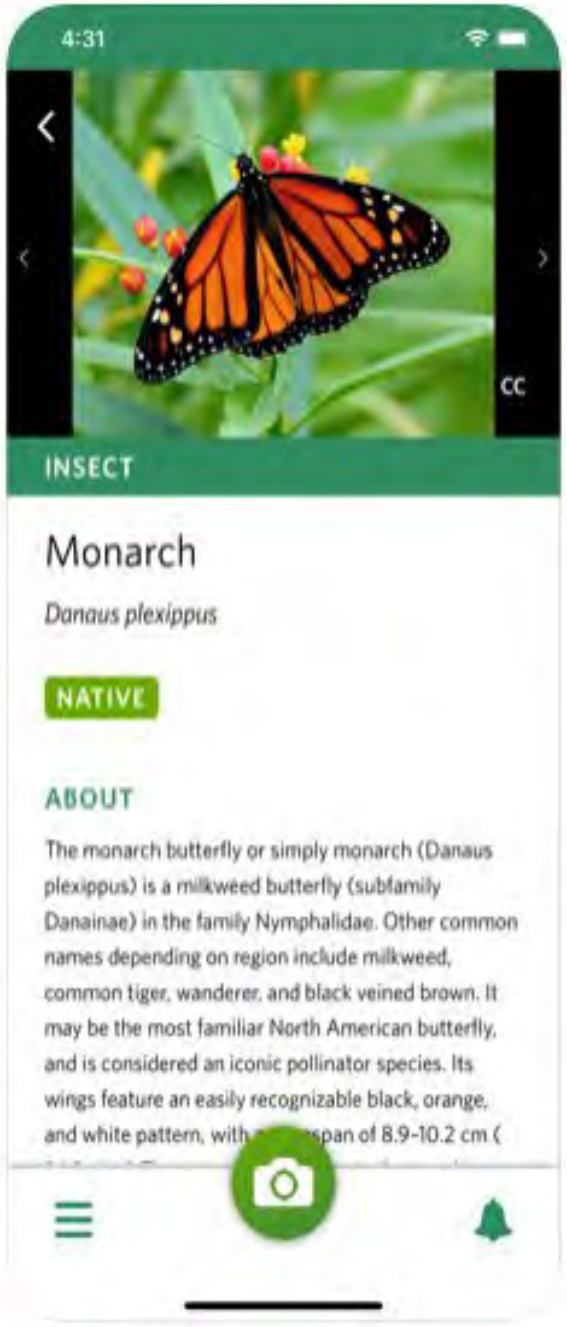
- **Advantages:**
- **Identity** → enhance knowledge, strengthen connection to community, self-efficacy (Smith et al., 2021)
- **Literacy** → barriers removed by non-text, accessible interfaces (Bonney et al., 2014)
- **Community service + instruction = *service learning*** → positive effects on identity & sense of belonging (Osborne et al., 1998)

Golden plover chick
Arctic tundra

Advantages of using Seek app technology in pedagogy

- Any level/rigor K-12 and beyond
- Any modality: online vs in-person, asynchronous vs synchronous
- Evidence-based, customizable
- Learner-technology interaction → culturally and contextually relevant

SPECIES
Monarch
Keep scanning the environment for organisms to identify!
CAMERA
PHOTOS


4:31
CC
INSECT
Monarch
Danaus plexippus
NATIVE
ABOUT
The monarch butterfly or simply monarch (Danaus plexippus) is a milkweed butterfly (subfamily Danainae) in the family Nymphalidae. Other common names depending on region include milkweed, common tiger, wanderer, and black veined brown. It may be the most familiar North American butterfly, and is considered an iconic pollinator species. Its wings feature an easily recognizable black, orange, and white pattern, with

11:32
SPECIES NEARBY
CUPERTINO
ALL SPECIES
California Poppy
Western Blue-eyed Grass
Western Fence Lizard
CHALLENGES
APRIL 2019
CONNECTIVITY CHALLENGE
Add observations with the Seek Camera to earn the Our Planet badge!
TAKE THE CHALLENGE

4:32
ACHIEVEMENTS
YOUR LEVEL
TADPOLE
Observe 3 species to get to the next level!
SPECIES BADGES

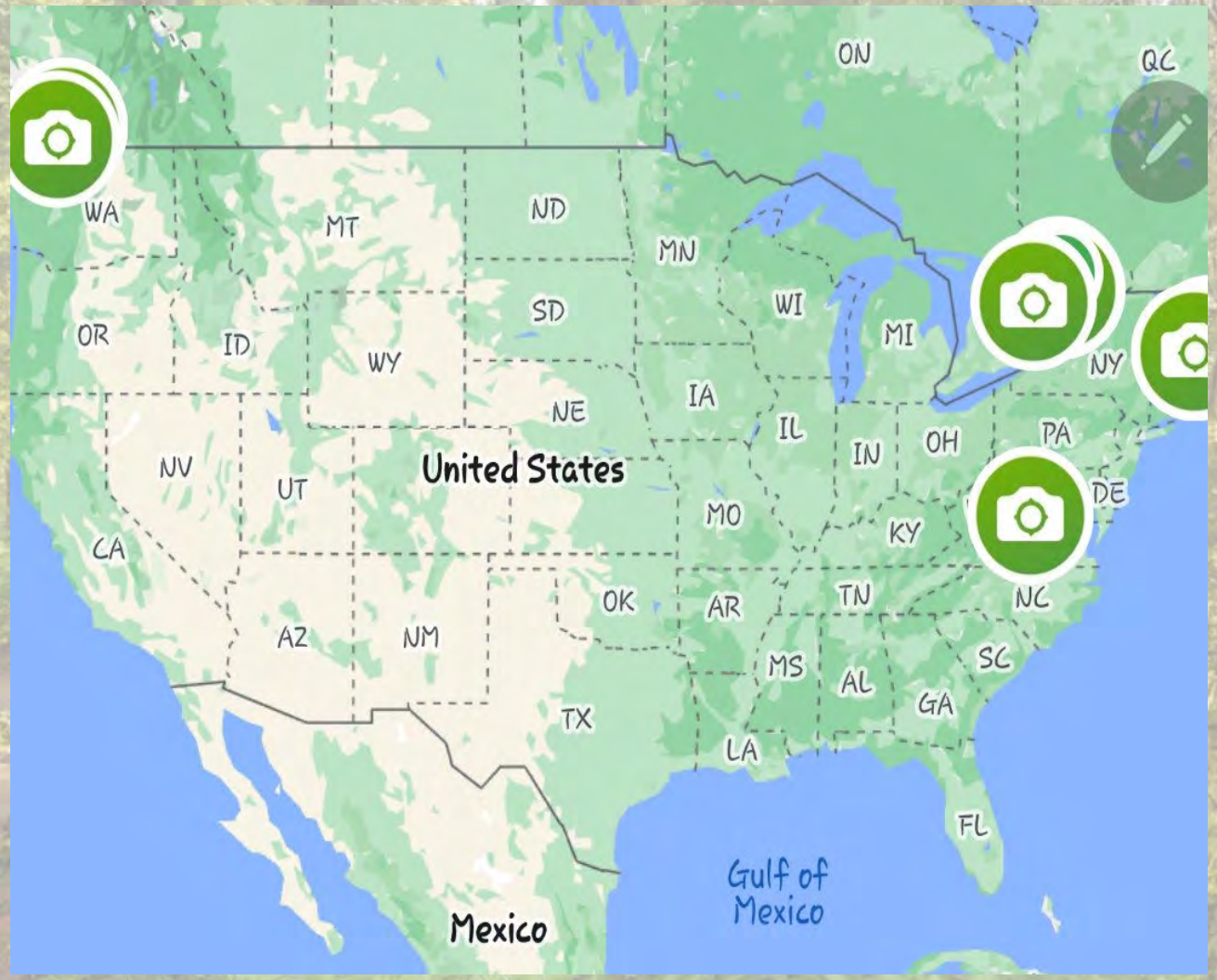
How structure lesson?

Provide step-by-step instructions in multiple modes

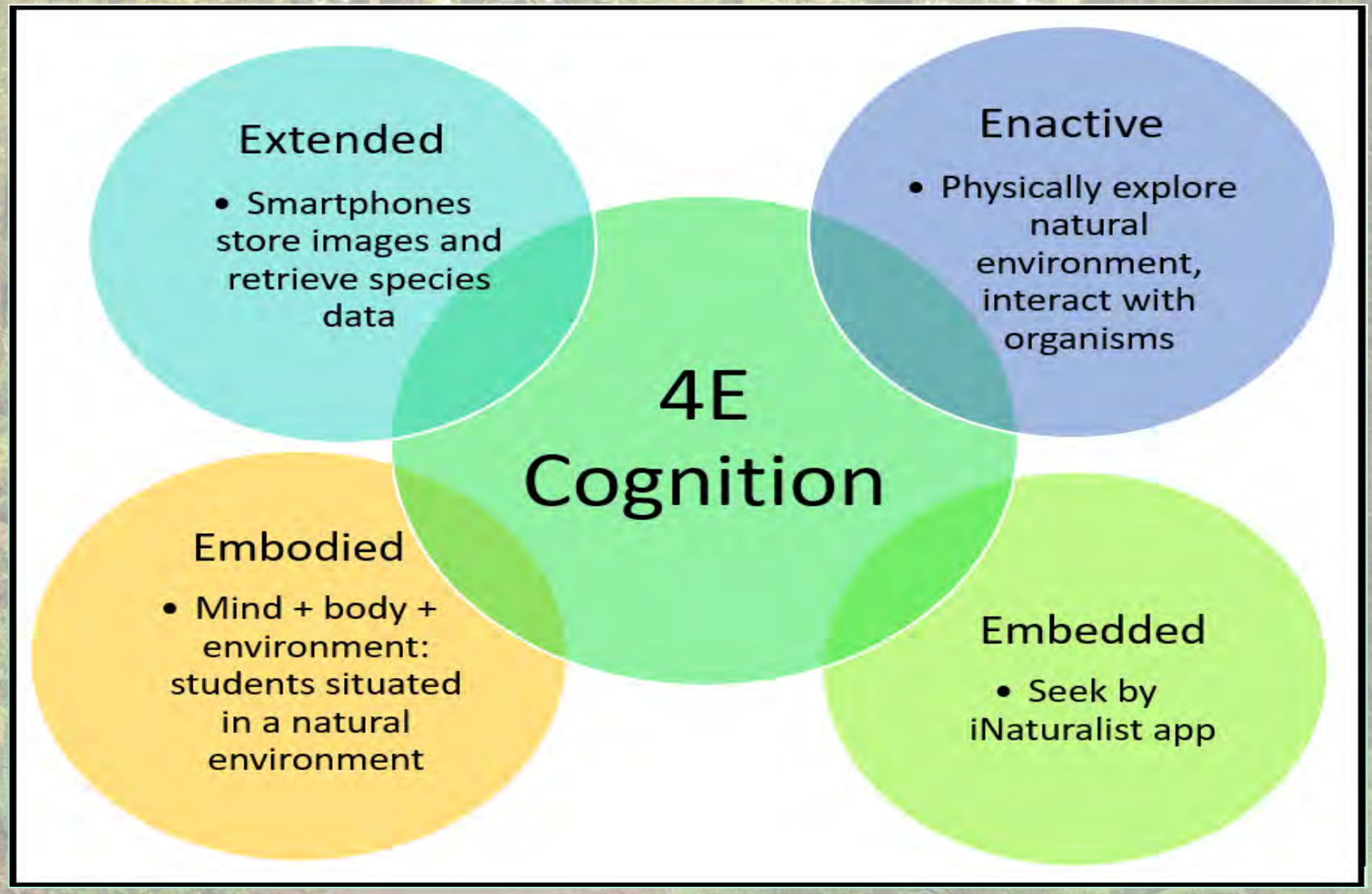
- Text, image, and signed forms
  - Scaffolding!

Lesson activity

- Part 1: capture species observations in natural environment with Seek app
  - bioliteracy = image + text
- Part 2: reflective expression in science framework



4E Cognition through Seek by iNaturalist



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Student quotes: emotive cognition

I feel *motivated* to find more new plants and animals. It is like *collecting Pokémon characters*.
After learning the species name of my plants and animals using the Seek app, I felt *intrigued* as I want to keep learning. It made me more aware of the environment surrounding me.
During the search for plants and animals I felt *like a park ranger explorer*. Identifying things and learning about plants was cool. I also felt *alittle crazy*, because here I am getting all the angles to try to identify a species and people are watching me thinking what is she doing. Overall, it was a *cool experience* to be on the hunt for living things.

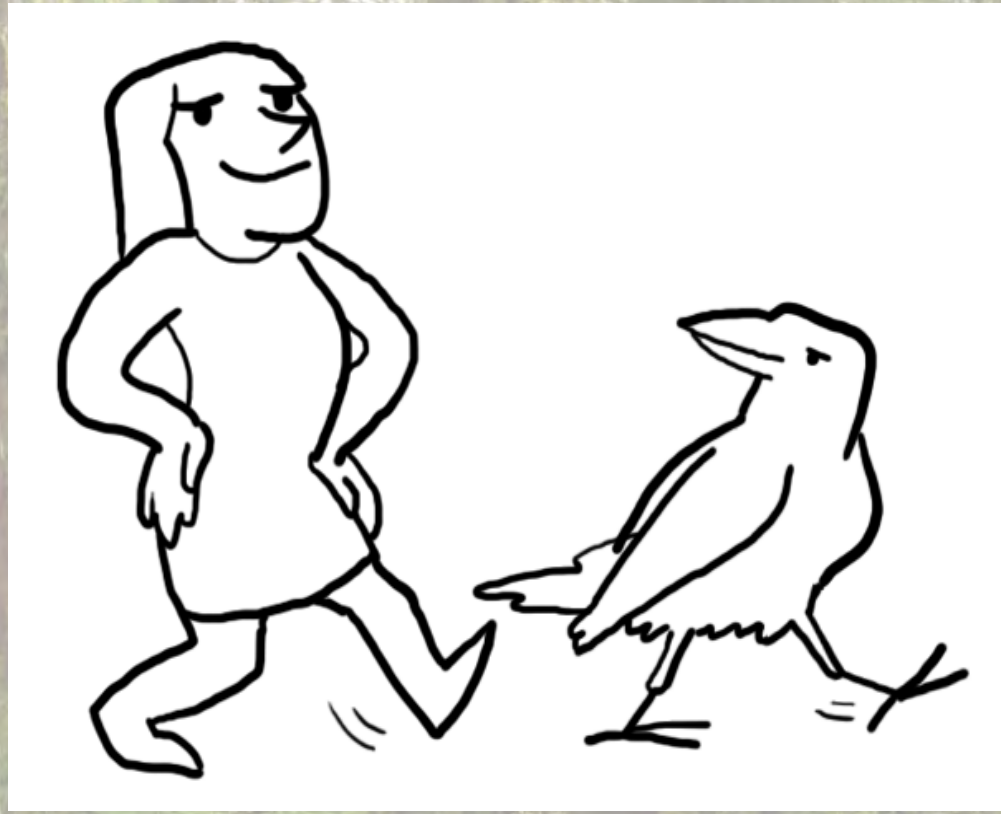
Student quotes continued

The Seek app made me *more interested* in exploring natural environment. I intend to keep using the app beyond the semester because the app's ability to identify species and provide detailed information about them is amazing and it added an *educational and engaging aspect* to my outdoor experience.
I am a nature fan, but I never took interest in learning names of the different plants. I *learned better* and I found that there were many different species for seagull which was *very interesting*.
I *feel more enlightened* to learn new scientific terminology about the different taxonomic classification names for identifying organisms.
I *felt adventurous* for the very first time. It's like having a nature expert in your pocket!
I *introduced my parents and sister* to this app. Them also being nature freaks, they immediately installed the app on their phones. They scan any new species they come across daily.

Summary

We discussed:

- Universal Design for Learning
- 4E's of cognition in pedagogy
- Seek by iNaturalist app
- TWO technology platforms demonstrated!
  - Mentimeter
  - Seek by iNaturalist



Ayers, E. (2024). Walking in an Environmental Scientist's Footprints: 4E Cognition Through the Seek by iNaturalist Citizen Science Application. *Journal of College Science Teaching*, 1-8.

Thank you!

- Questions?

- Playtime!
  1) Download Seek app on your smartphone
  2) Use the Seek app to identify these plants!