

Museum of Science[®]

Productive Struggle Webinar Series

Module 4: Applying and Testing the Framework

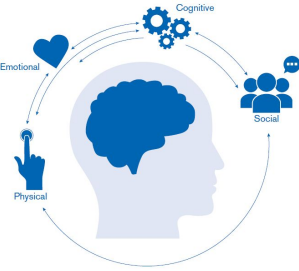
September 3, 2020

Current Speaker




Beth Malandain
Senior Exhibit Designer
Museum of Science, Boston
she, her, hers

Webinar series




Module 1:
Why emotion?

August 13




Module 2: What is
productive struggle?

August 20



Module 3: Designing for
productive struggle

August 27



Module 4: Applying and
testing the framework

September 3

Who are we?

- Sunewan Paneto, Sr. Research/Evaluation Assistant, Research and Evaluation
- Katharina Marino, Exhibit Content Developer, Exhibit Content Development
- Beth Malandain, Sr. Exhibit Designer, Exhibit Design

Agenda

- Review Framework and DBR method
- *Mammal Skull Mystery* background
- *Mystery Skulls Case Study*: the story of Disrupt & Support
- Key Takeaways



1. Natural History Exhibit
(Sneak)



2. Natural History Exhibit

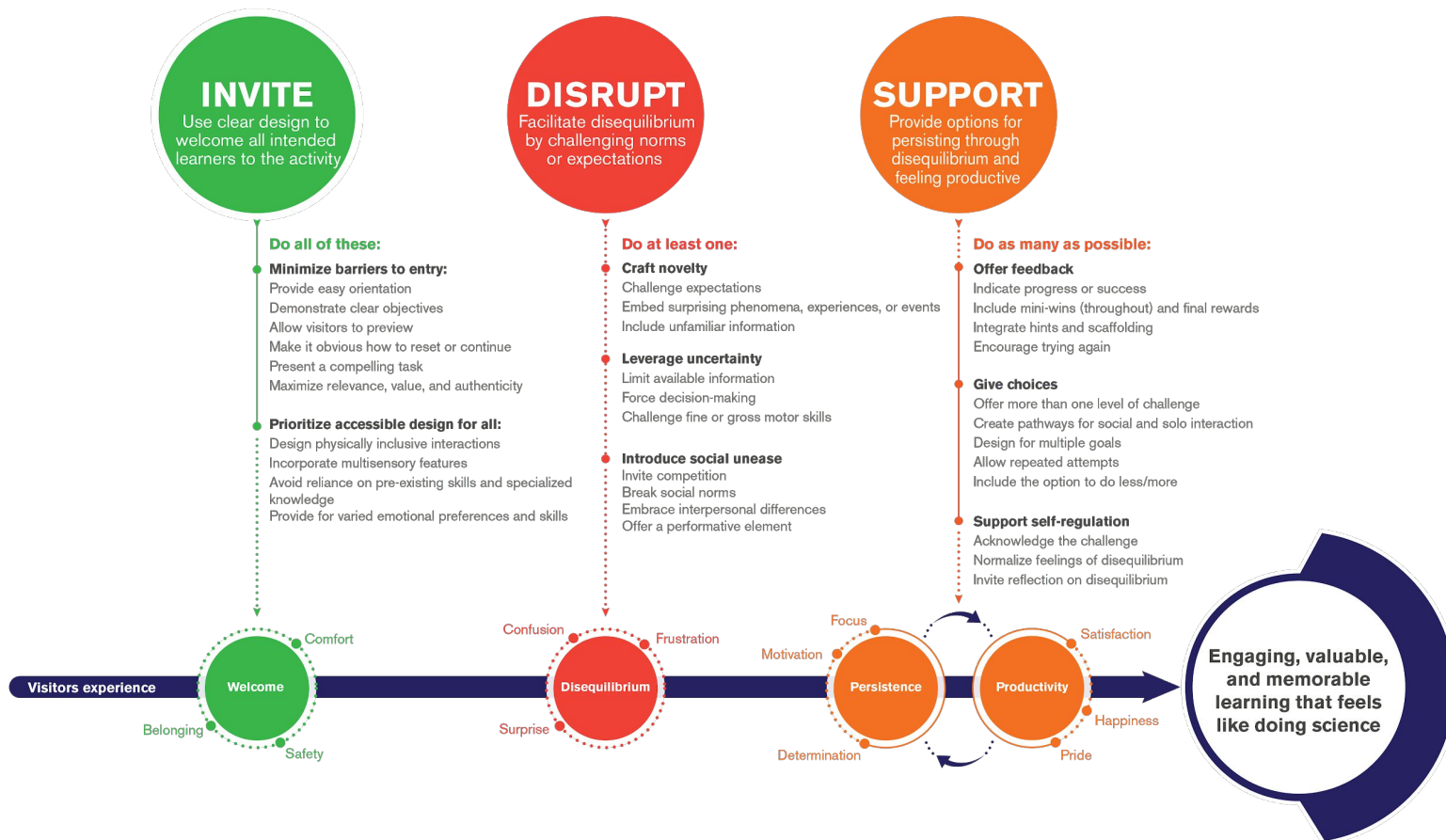


3. Physical Sciences Exhibit

Why Skulls?



Designing for Productive Struggle



INVITE

Use clear design to welcome all intended learners to the activity

Do all of these:

Minimize barriers to entry:

- Provide easy orientation
- Demonstrate clear objectives
- Allow visitors to preview
- Make it obvious how to reset or continue
- Present a compelling task
- Maximize relevance, value, and authenticity

Prioritize accessible design for all:

- Design physically inclusive interactions
- Incorporate multisensory features
- Avoid reliance on pre-existing skills and specialized knowledge
- Provide for varied emotional preferences and skills

DISRUPT

Facilitate disequilibrium by challenging norms or expectations

Do at least one:

Craft novelty

- Challenge expectations
- Embed surprising phenomena, experiences, or events
- Include unfamiliar information

Leverage uncertainty

- Limit available information
- Force decision-making
- Challenge fine or gross motor skills

Introduce social unease

- Invite competition
- Break social norms
- Embrace interpersonal differences
- Offer a performative element

SUPPORT

Provide options for persisting through disequilibrium and feeling productive

Do as many as possible:

Offer feedback

- Indicate progress or success
- Include mini-wins (throughout) and final rewards
- Integrate hints and scaffolding
- Encourage trying again

Give choices

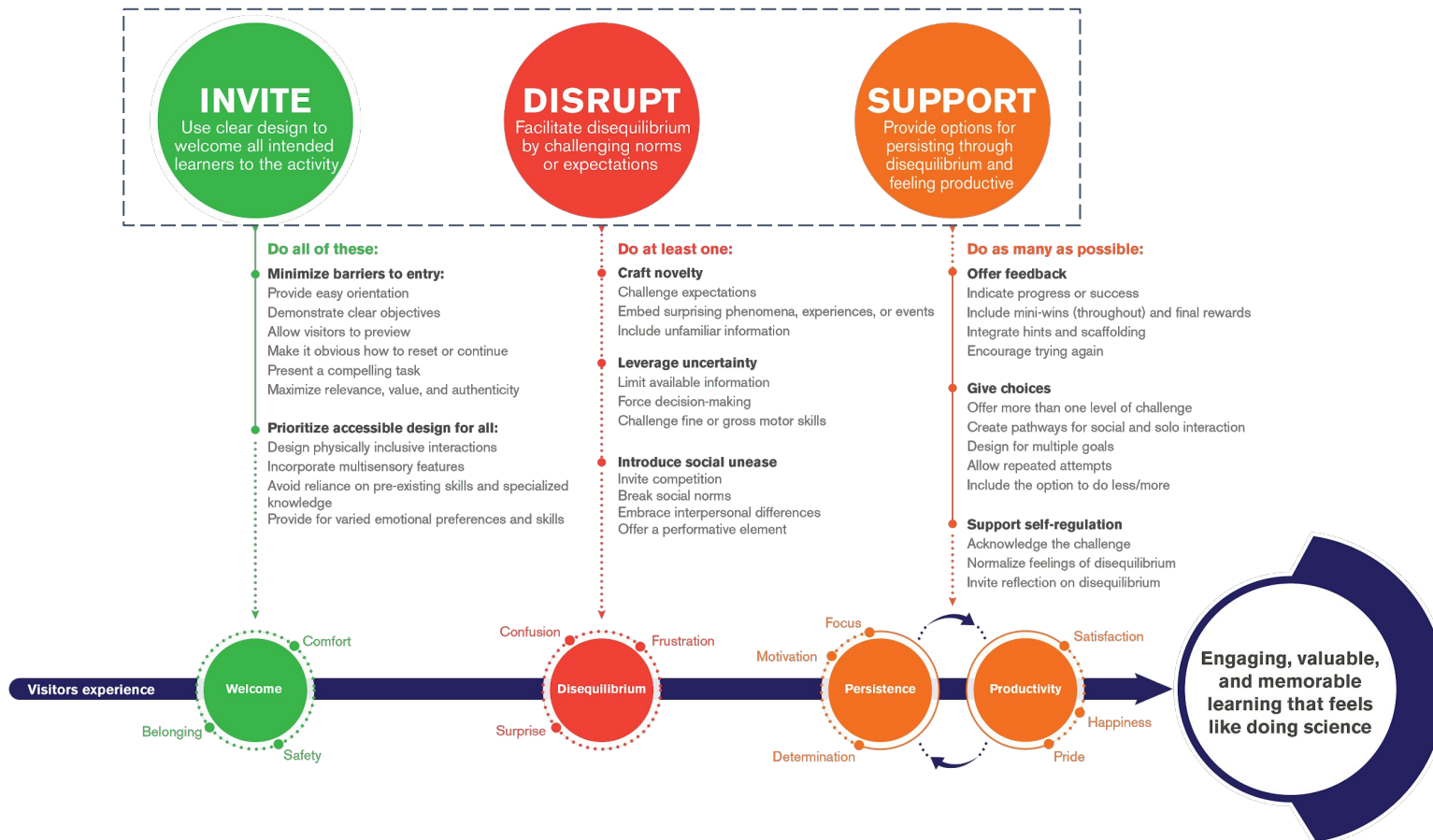
- Offer more than one level of challenge
- Create pathways for social and solo interaction
- Design for multiple goals
- Allow repeated attempts
- Include the option to do less/more

Support self-regulation

- Acknowledge the challenge
- Normalize feelings of disequilibrium
- Invite reflection on disequilibrium

Engaging, valuable, and memorable learning that feels like doing science

Designing for Productive Struggle



INVITE

Use clear design to welcome all intended learners to the activity

DISRUPT

Facilitate disequilibrium by challenging norms or expectations

SUPPORT

Provide options for persisting through disequilibrium and feeling productive

Current speaker



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What is Design-Based Research? (DBR)

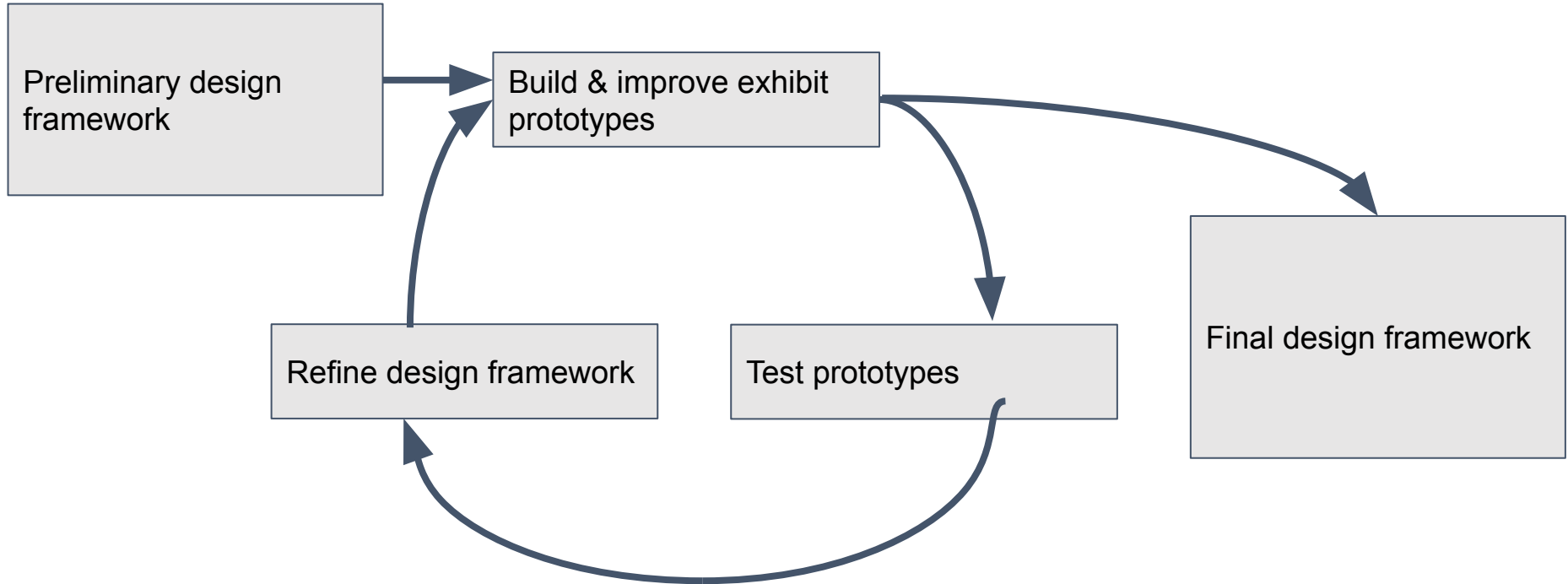
In DBR, “...**instructional design and research** are interdependent. On the one hand, the design of learning environments serves as the **context for research**, and, on the other hand, ongoing and retrospective analyses are conducted in order to **inform the improvement** of the design.” (Cobb & Gravemeijer, 2008)

DBR was “developed as a way to carry out **formative research** to test and refine **educational designs** based on principles derived from **prior research**” (Collins, Joseph, & Bielaczyc, 2004)

Background Information

- Three exhibits
 - Sneak (refurbishment)
 - Skulls (refurbishment)
 - Air (new)
- Data collection included
 - Baseline
 - Formative
 - Final study
- 444 youth ages 10-17

Our DBR Process



Current Speaker



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Mammal Skull Mystery



Invite

Do all of these:

Minimize barriers to entry:

Provide easy orientation

Demonstrate clear objectives

Allow visitors to preview

Make it obvious how to reset or continue

Present a compelling task

Maximize relevance, value, and authenticity

Prioritize accessible design for all:

Design physically inclusive interactions

Incorporate multisensory features

Avoid reliance on pre-existing skills and specialized knowledge

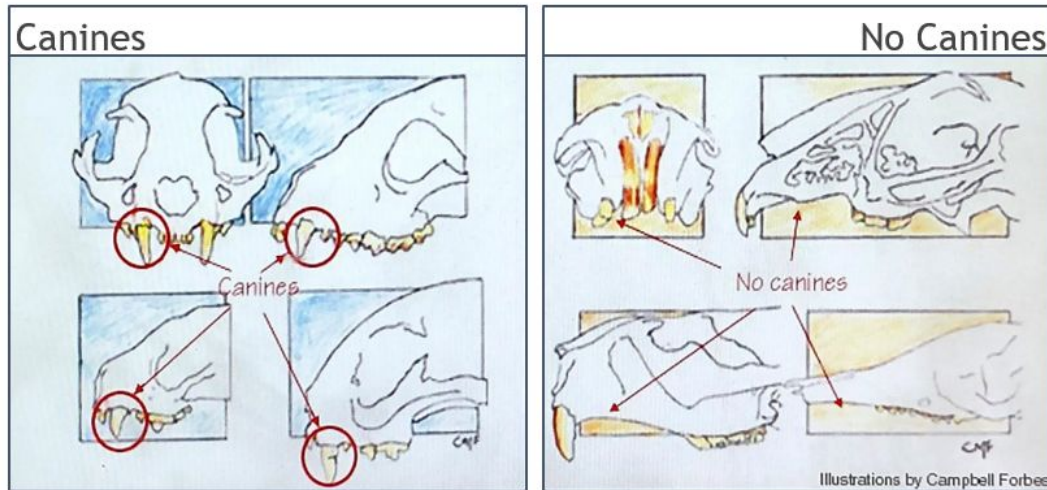
Provide for varied emotional preferences and skills



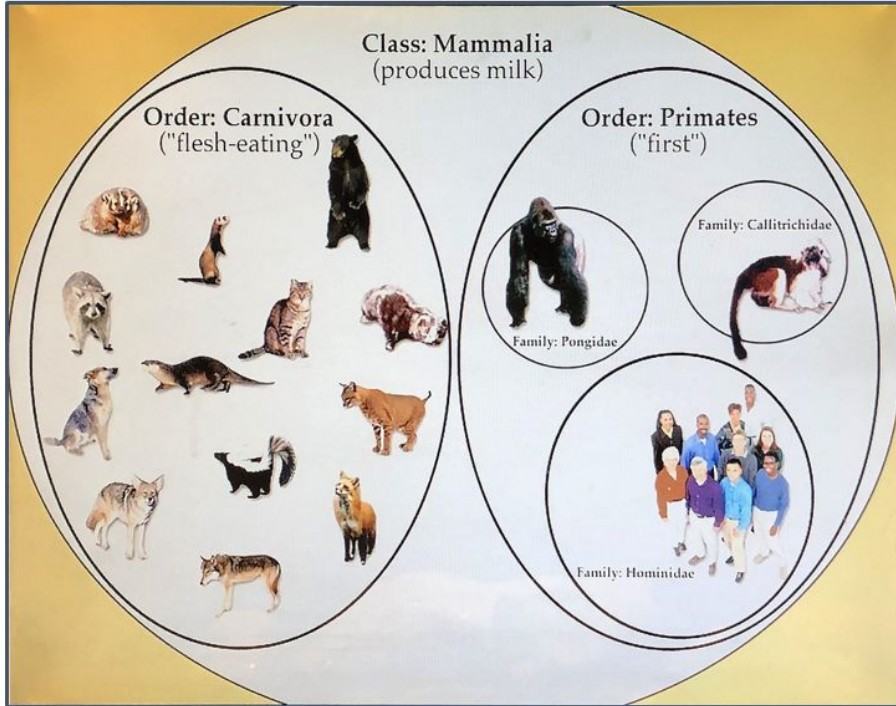
Mammal Skull Mystery Visitor Experience Activity



1. Does this skull have canine teeth?



Left Screen



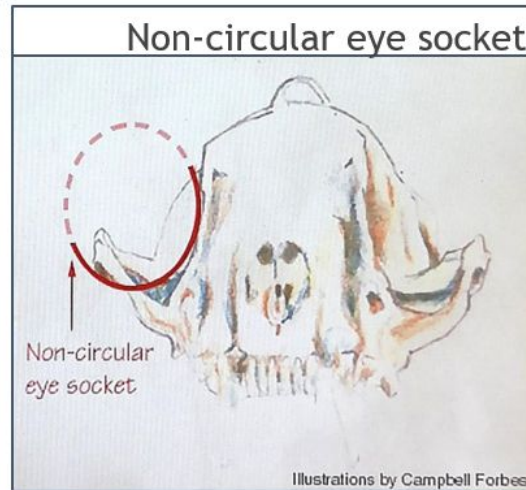
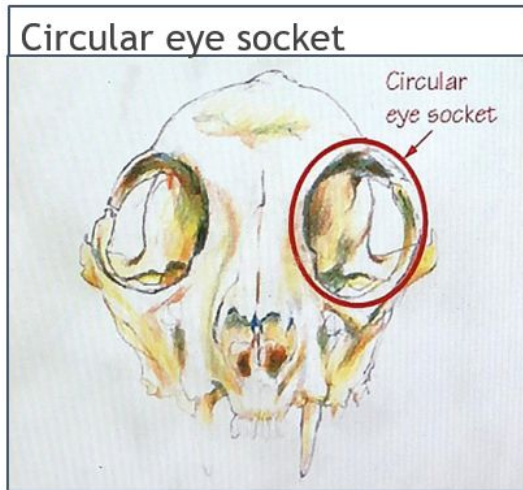
Right Screen

MAMMAL SKULL MYSTERY

Mammals with canine teeth are meat-eaters.
Many are in the scientific order Carnivora.





2. Is the eye socket shaped like a nearly completed circle?



Left Screen

Bobcat

Class: Mammalia (produces milk)
Order: Carnivora ("flesh-eating")
Family: Felidae (cat family)
Genus: *Felis* ("cat")
Species: *rufus* ("red")



Right Screen

MAMMAL SKULL MYSTERY

Congratulations !
You've solved a mammal skull mystery.
If you would like to solve another mystery,
press YES.

But is it a bobcat skull?



**We might
never know.**



MAMMAL SKULL MYSTERY

This animal hunts mostly at night, so it needs to have good eyes. Skull 1 is that of a bobcat, a carnivore in the cat family (family: Felidae).



What other groups of animals have circular eye sockets?
Look in the skull case to find out.

Invite

Do all of these:

Minimize barriers to entry:

Provide easy orientation

Demonstrate clear objectives

Allow visitors to preview

Make it obvious how to reset or continue

Present a compelling task

Maximize relevance, value, and authenticity

Prioritize accessible design for all:

Design physically inclusive interactions

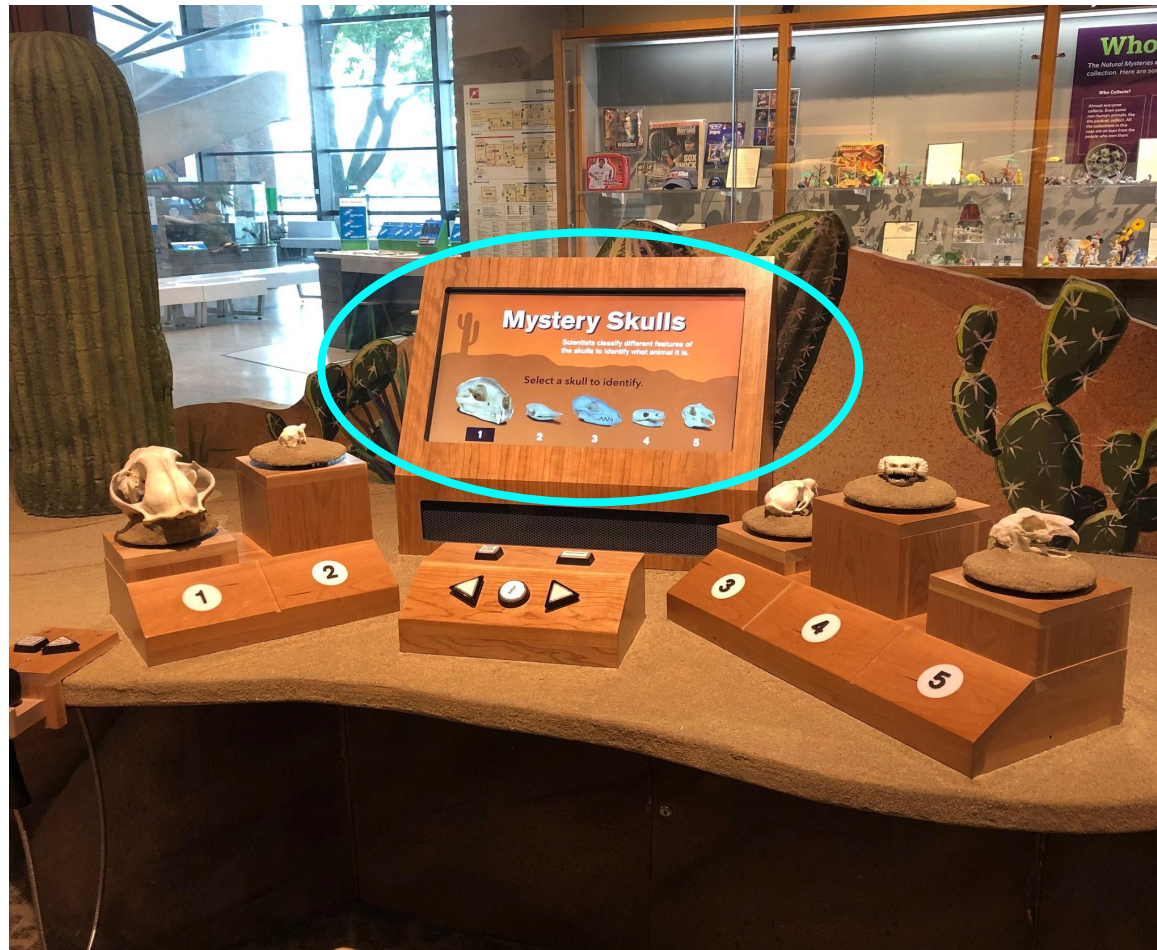
Incorporate multisensory features

Avoid reliance on pre-existing skills and specialized knowledge

Provide for varied emotional preferences and skills





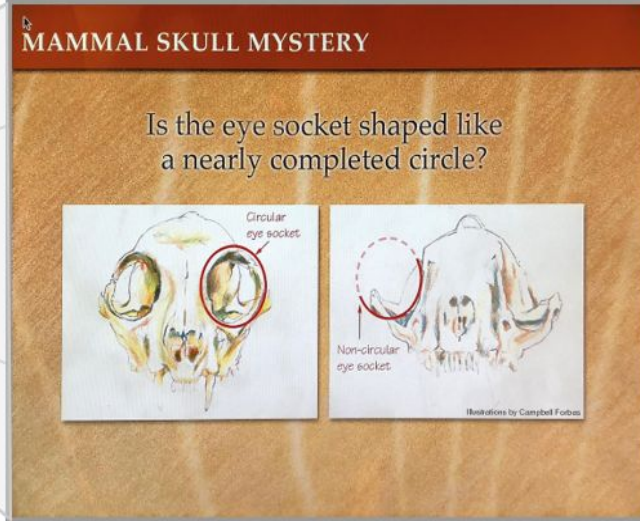


Do we need both?

Left Support Screen



Right Activity Screen



Current speakers



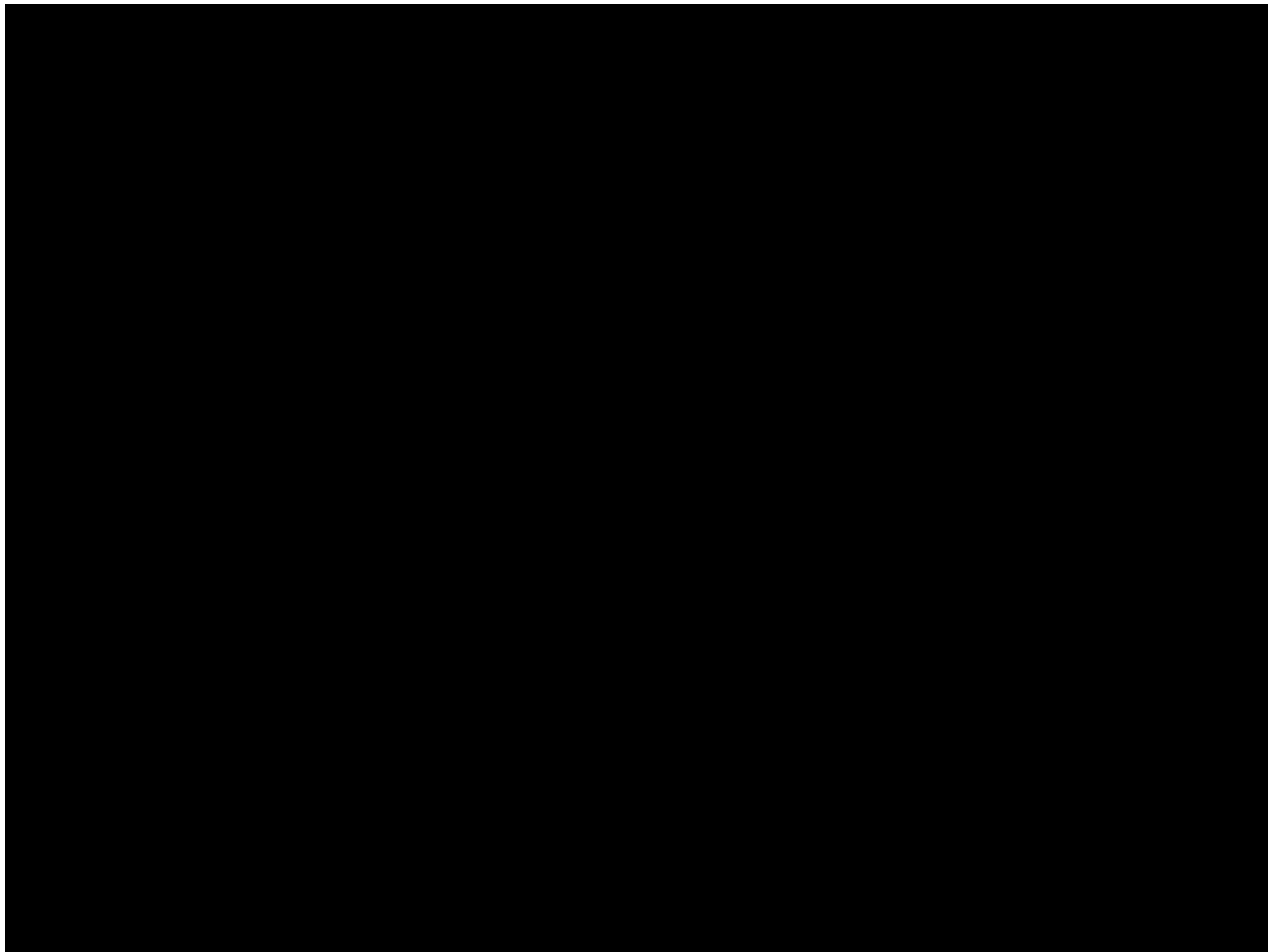
Katharina Marino

Exhibit Content Developer
Museum of Science, Boston
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Sunewan Paneto

Senior Research & Evaluation Assistant
Museum of Science, Boston
she, her, hers



Support

Do as many as possible:

Offer feedback

Indicate progress or success

Include mini-wins (throughout) and final rewards

Integrate hints and scaffolding??

Encourage trying again

Give choices

Offer more than one level of challenge

Create pathways for social and solo interaction

Design for multiple goals

Allow repeated attempts

Include the option to do less/more

Support self-regulation

Acknowledge the challenge

Normalize feelings of disequilibrium

Invite reflection on disequilibrium

Invite

Do all of these:

Minimize barriers to entry:

Provide easy orientation X

Demonstrate clear objectives X

Allow visitors to preview

Make it obvious how to reset or continue

Present a compelling task

Maximize relevance, value, and authenticity

Prioritize accessible design for all:

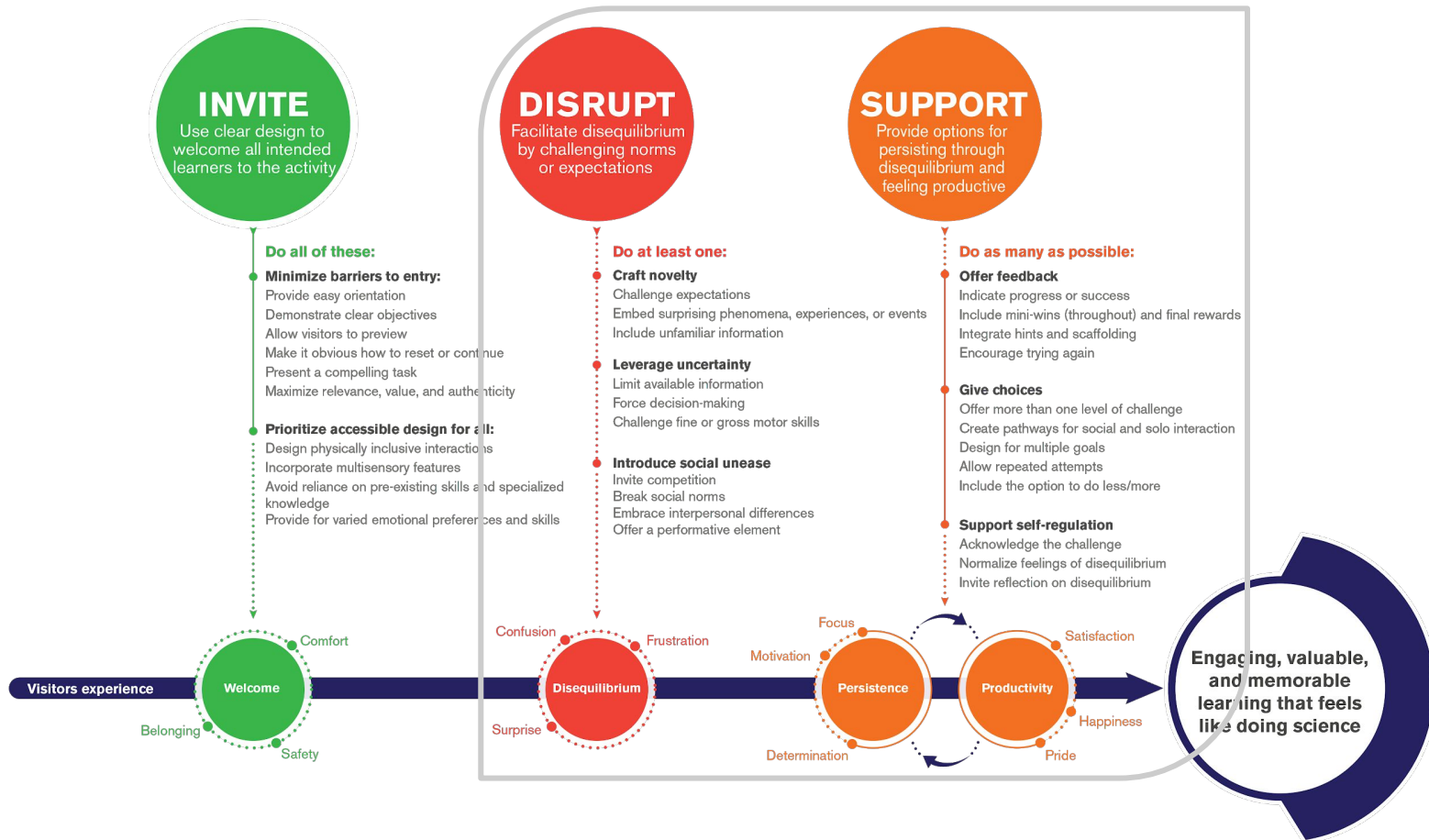
Design physically inclusive interactions

Incorporate multisensory features

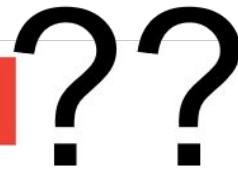
Avoid reliance on pre-existing skills and specialized knowledge

Provide for varied emotional preferences and skills

Designing for Productive Struggle



Disrupt



Do at least one:

● Craft novelty

Challenge expectations

Embed surprising phenomena, experiences, or events

Include unfamiliar information

● Leverage uncertainty

Limit available information

Force decision-making

Challenge fine or gross motor skills

● Introduce social unease

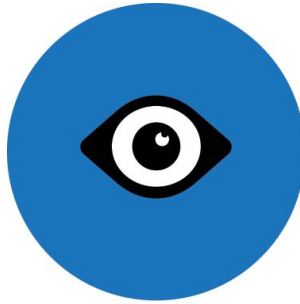
Invite competition

Break social norms

Embrace interpersonal differences

Offer a performative element

What methods did we use?



Observations



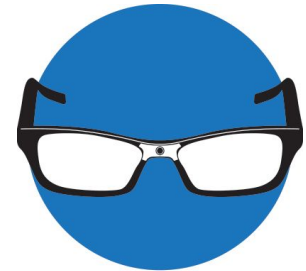
Interviews



Surveys



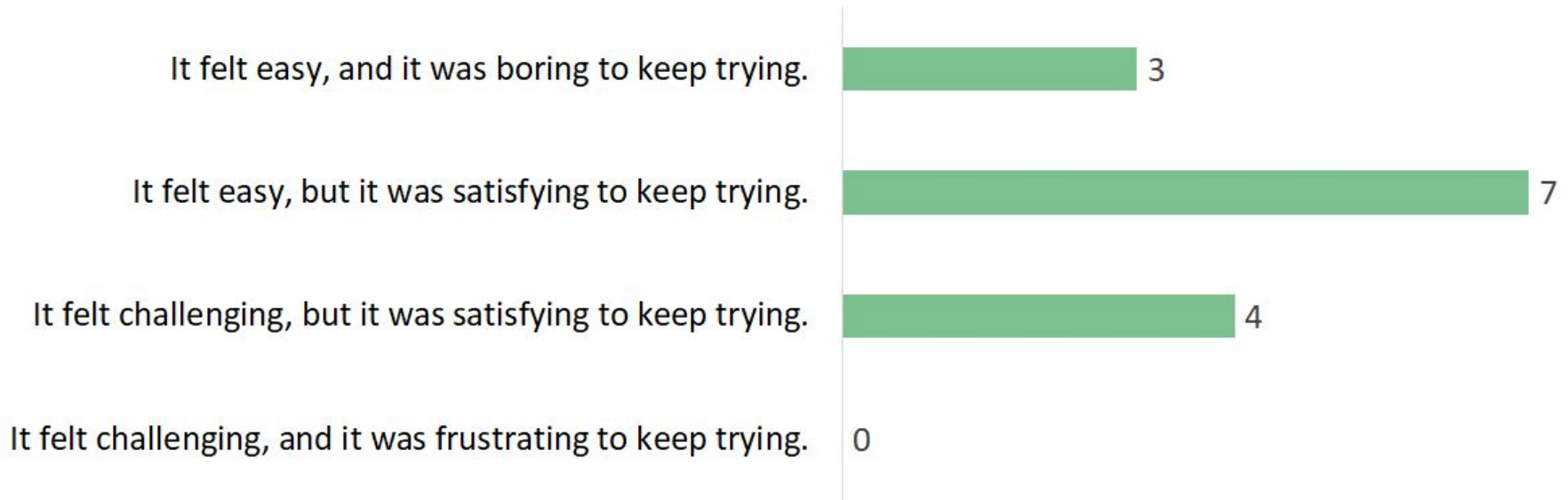
Guided Recall
Activities



Technology-
based data
collection

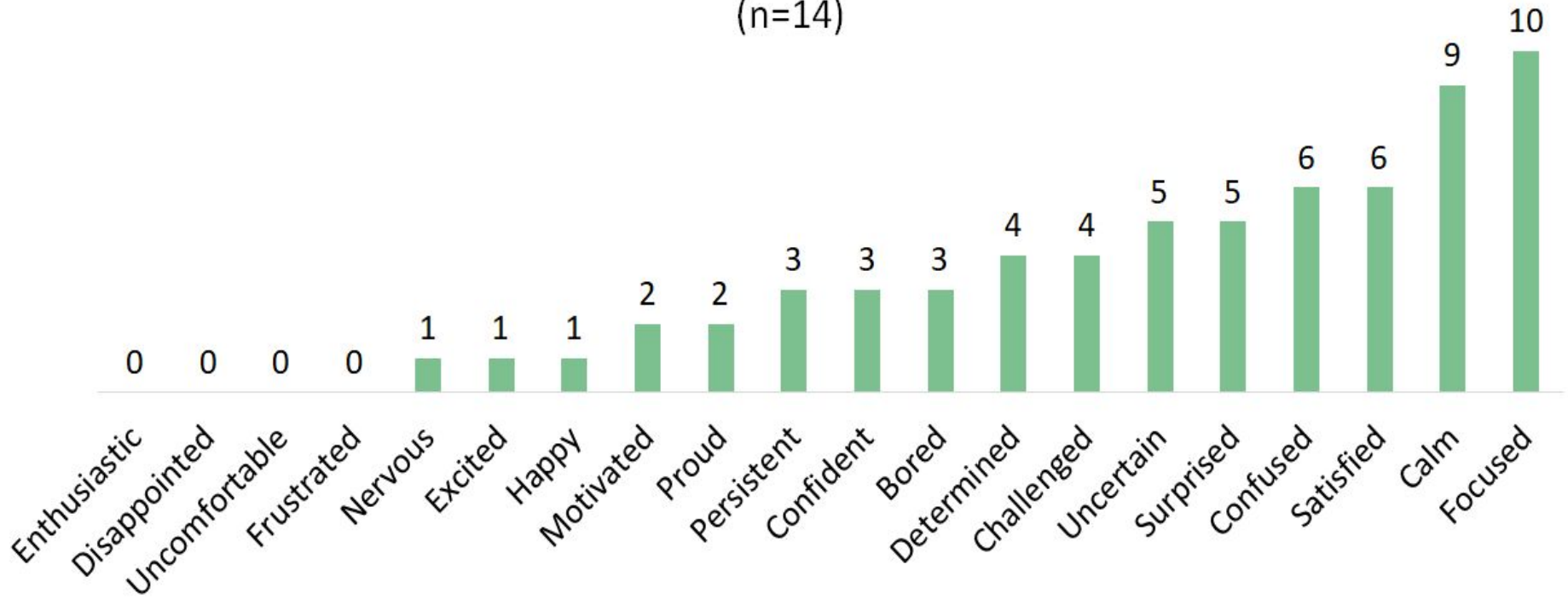
While people found the original exhibit satisfying, they also found it easy.

Which statement best represents how you felt at this exhibit? (n=14)

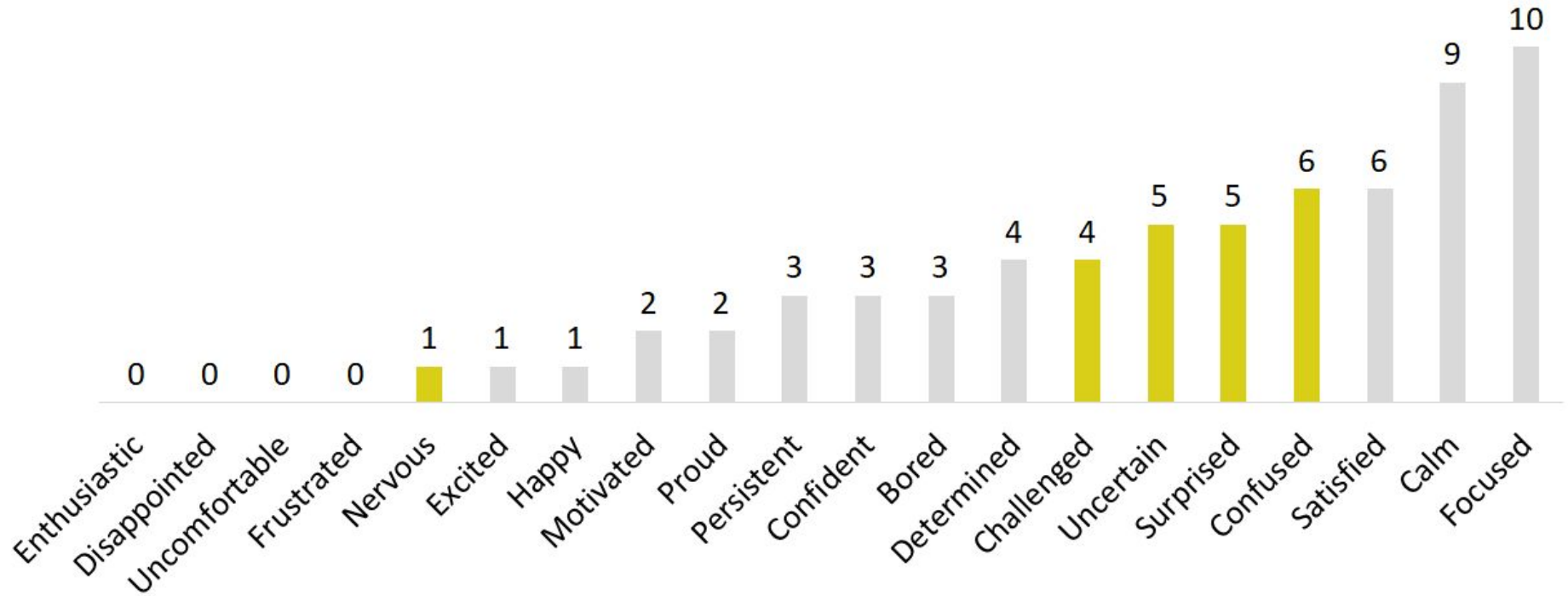


Participants experienced a range of emotions at the original exhibit

Did you feel any of the following emotions while you were at this activity?
(n=14)



...but there were low levels of emotional disequilibrium.



Forcing decision
making

**Withholding
information**

**Including
unfamiliar
information**

Teaching a rule and then
breaking the rule

Including unusual
looking skulls

**Allow handling
animal skulls**

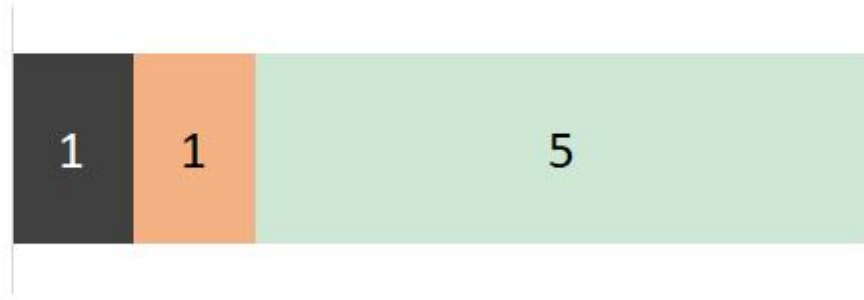
**Which of these do you think
achieved disequilibrium?**

Handling skulls?

Most visitors did feel that touching the skulls was an unusual experience...

How much do you agree or disagree with the following statement? (n=7 groups)

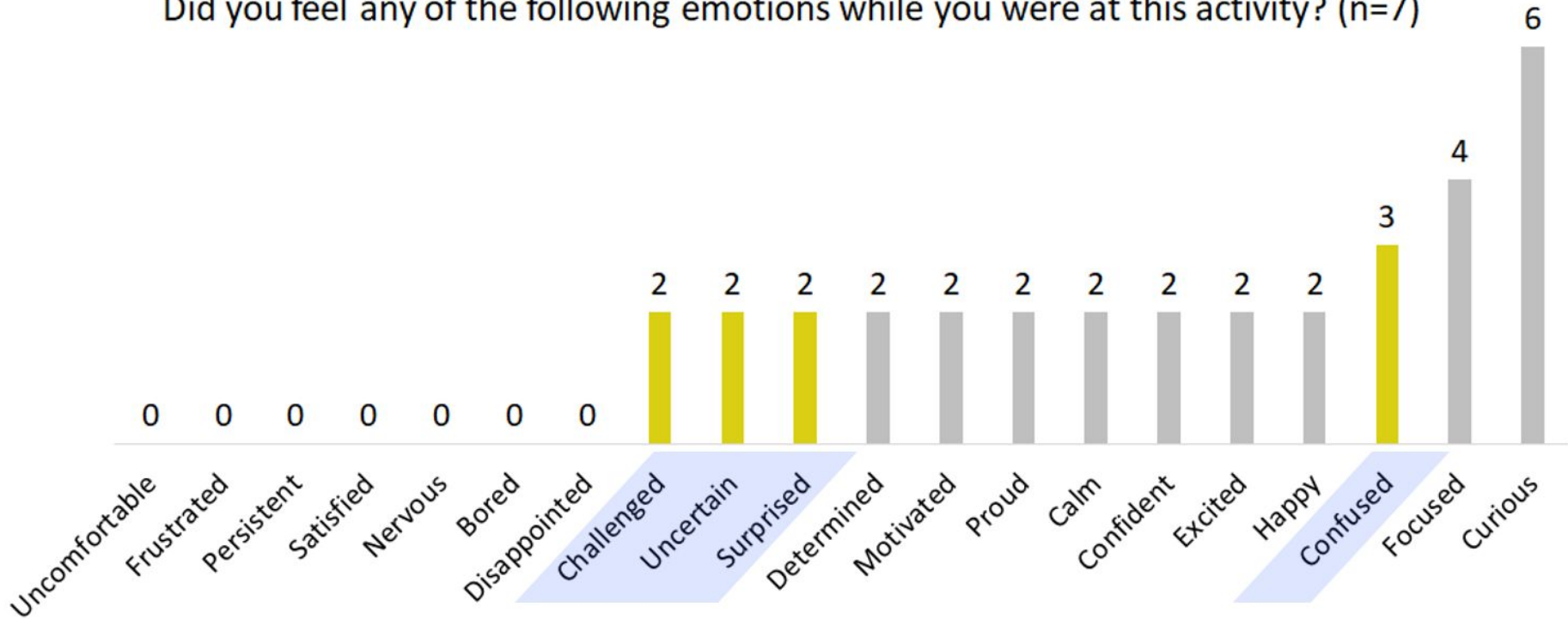
Touching the skulls was an unusual experience.



■ Strongly disagree ■ Disagree ■ Agree

. . . but overall feelings of disequilibrium were low.

Did you feel any of the following emotions while you were at this activity? (n=7)



Unusual skulls?





Disrupt



Do at least one:

● Craft novelty

Challenge expectations

Embed surprising phenomena, experiences, or events

Include unfamiliar information

● Leverage uncertainty

Limit available information

Force decision-making

Challenge fine or gross motor skills

● Introduce social unease

Invite competition

Break social norms

Embrace interpersonal differences

Offer a performative element

Disrupt

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but...

Withholding information?

Observations

Skulls Story Testing

Selects skull (circle):

- 1
- 2

Selects feature (label 1st, 2nd, 3rd):

- _____ Teeth
- _____ Eyes
- _____ Nose

At any point using this skull (tally):

- _____ Correct
- _____ Incorrect


















Uses the following? (tally)

- _____ Looks at another skull – which? _____
- _____ Go back button
- _____ Hint – colored skull on screen

Other key actions?

- Interacts with another person
- Exhibit usability issue

All groups had more correct answers than incorrect.

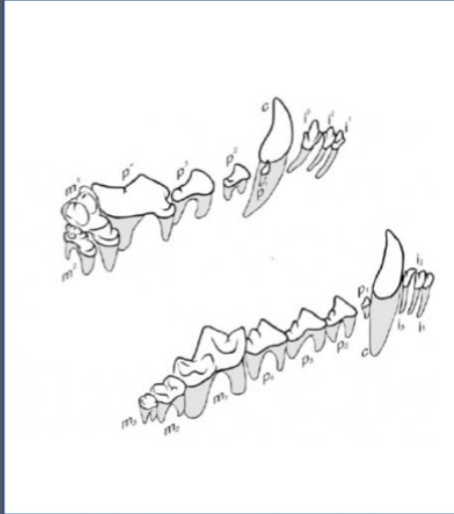
	First Skull			Second Skull		
	Animal	# correct	# incorrect	Animal	# correct	# incorrect
Group 1		4	2		5	2
Group 2		5	1			
Group 3		2	2			
Group 4		2	0		5	1
Group 5		3	3		4	0
Visitor 6		10	1			
Visitor 7		7	1			
Visitor 8		4	3		7	2
Visitor 9		2	1			
Visitor 10		7	1		7	1
Visitor 11		5	2		6	3

Total correct: 89

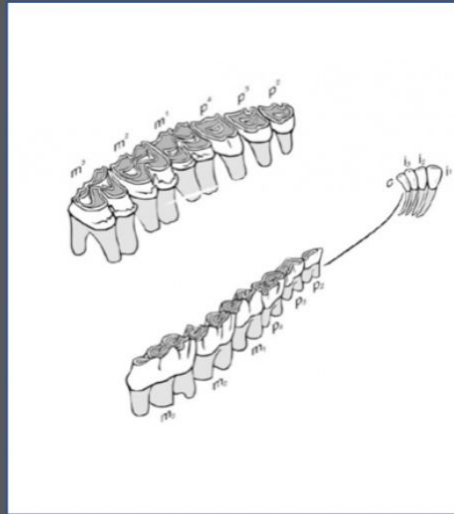
Total incorrect: 26

What kind of teeth does this skull have?

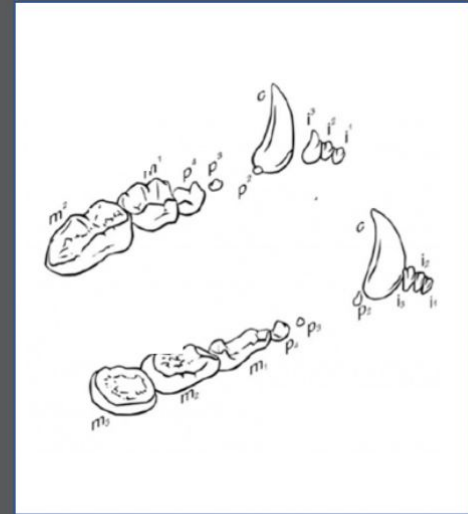
Sharp and Pointy



Flat



Combination of both



1

How would you describe
the teeth of Skull 1?

Sharp and pointy

Broad and flat

Combination of both

2

There is a better answer.

Learn more about teeth

Try again

3

Sharp and pointy

Broad and flat

Combination of both



Try again

Disrupt



Do at least one:

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but...

Disrupt

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~~X~~ Limit available information

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Support

Do as many as possible:

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Indicate progress or success

Include mini-wins (throughout) and final rewards

Integrate hints and scaffolding !!

Encourage trying again !!

● Give choices

Offer more than one level of challenge

Create pathways for social and solo interaction

Design for multiple goals

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Include the option to do less/more

● Support self-regulation

Acknowledge the challenge

Normalize feelings of disequilibrium

Invite reflection on disequilibrium

Force Decision-Making?

Mystery Skulls

Scientists classify different features of skulls to identify what animals they came from.

Select a skull to identify.



1



2



3



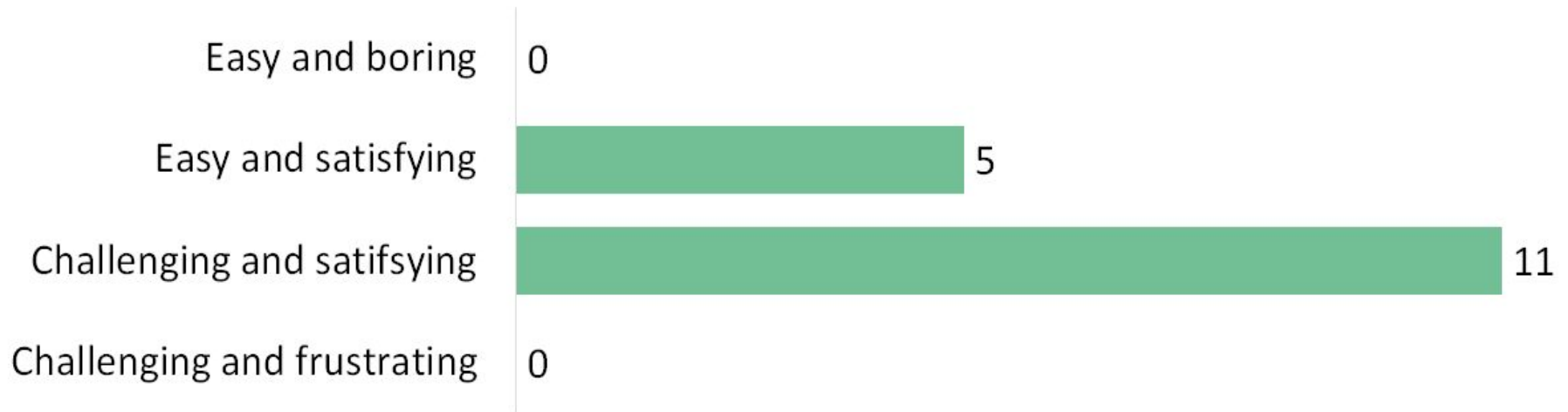
4



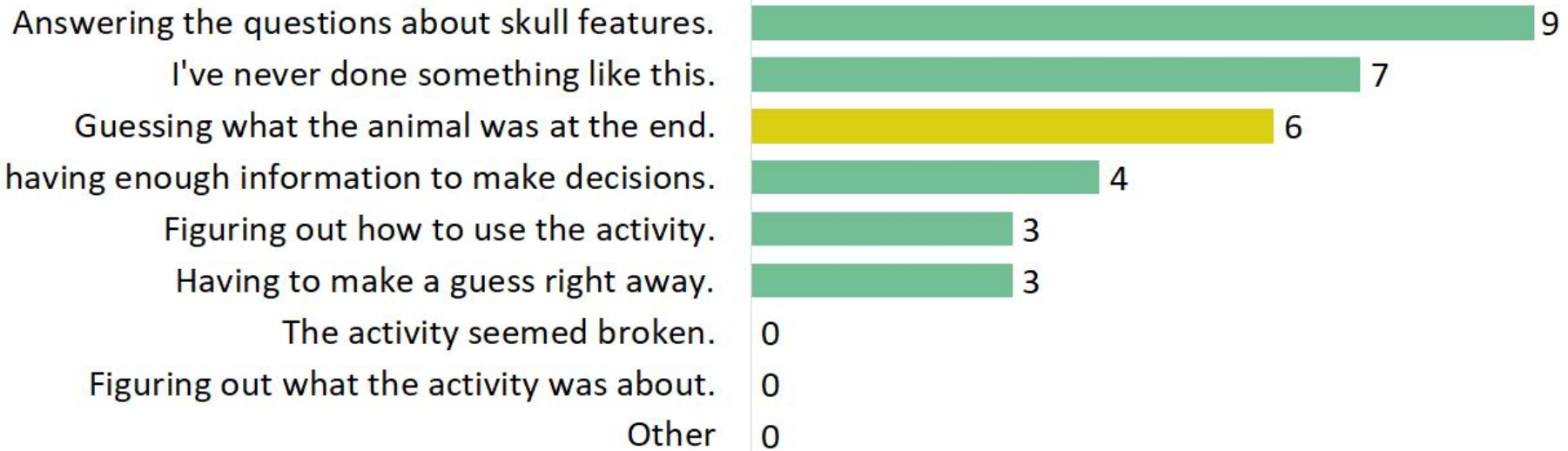
5

[Virtual Exhibit](#)

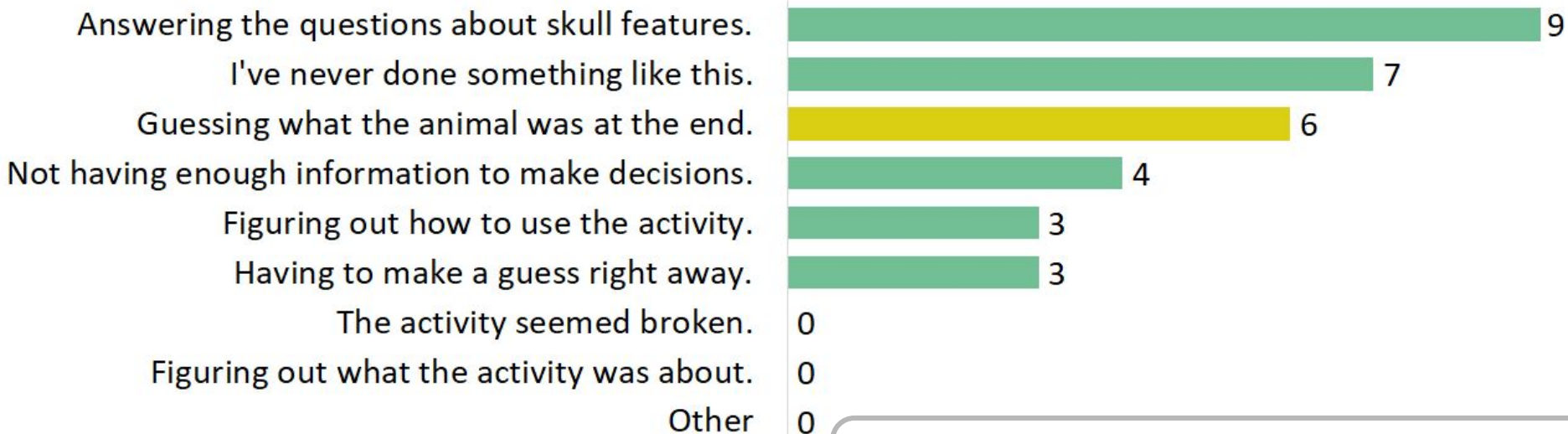
Which of the following statements represent your experience with this activity? (n=16 individuals)



What made you feel [disequilibrium] at this activity? (n=16 individuals)



What made you feel [disequilibrium] at this activity? (n=16 individuals)



“It made me second guess myself!”

-Male, 13

Disrupt



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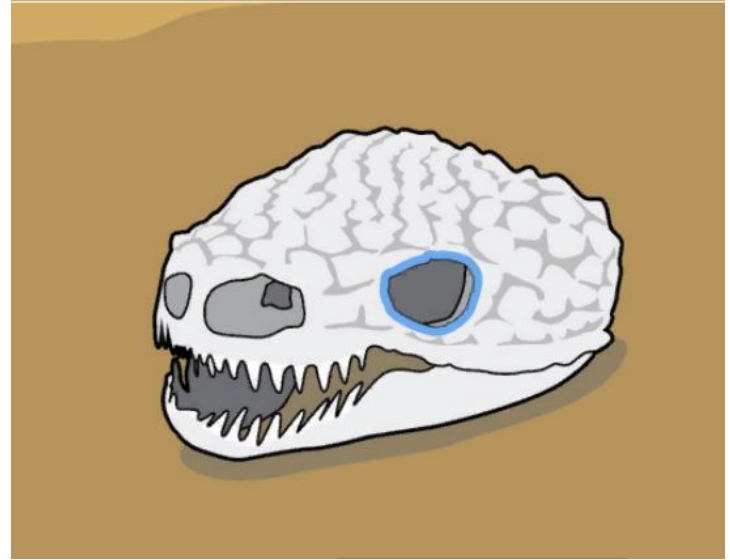
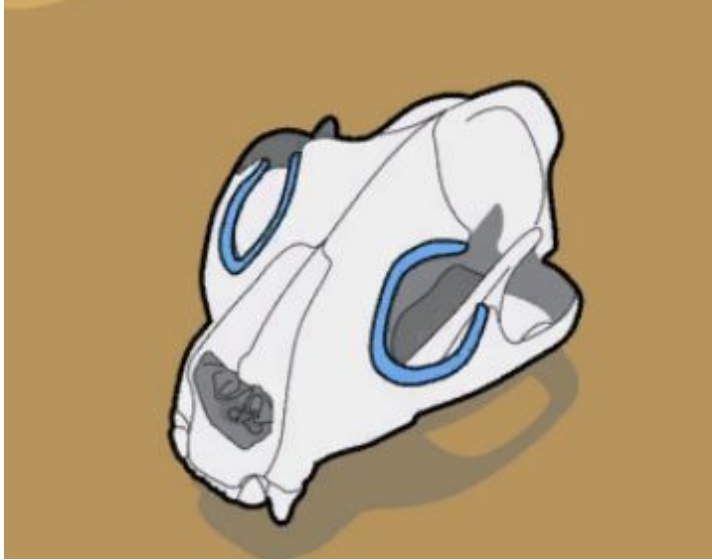
Offer a performative element



and...

Multiple places for disequilibrium

Breaking the Rule



*“Eyes in the front, on the hunt.
Eyes on the side, run and hide.”*

Sagittal Crest

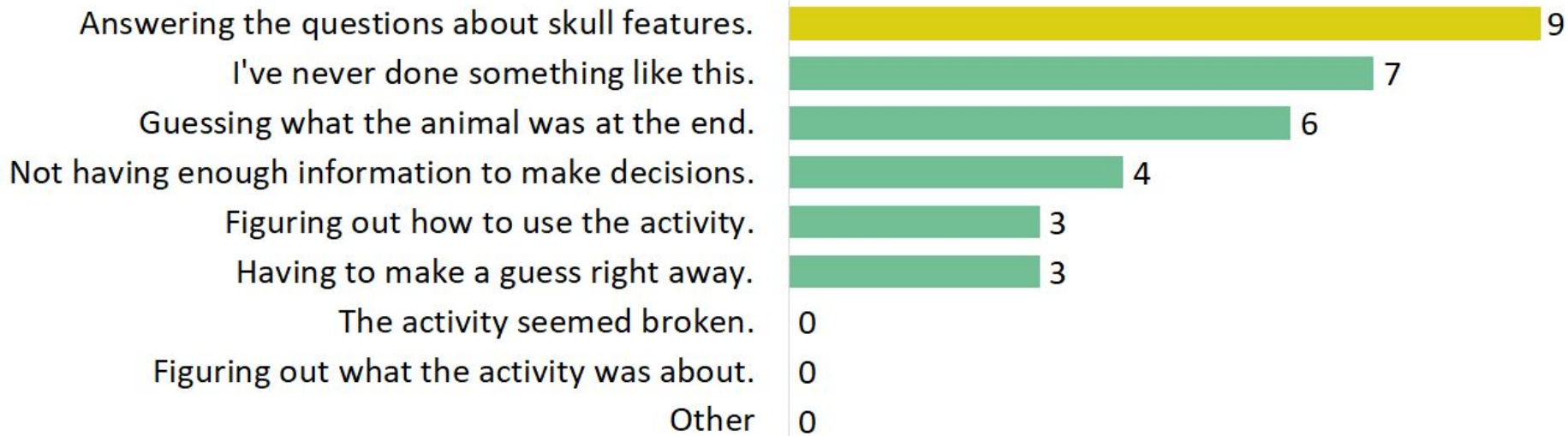


Click & drag to
rotate skull

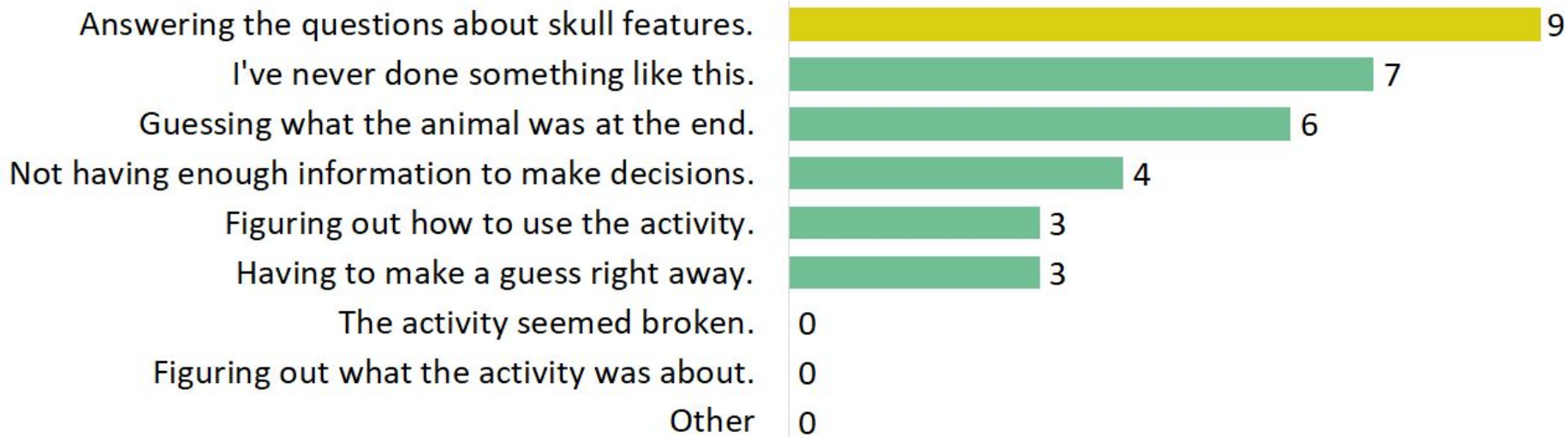
Length: 8.3 in / 21 cm



What made you feel [disequilibrium] at this activity? (n=16 individuals)



What made you feel [disequilibrium] at this activity? (n=16 individuals)



- **Female, 16:** The ridge crest part. **Female, 14:** But after it explains it, it was okay.
- **Female, 13:** The crest or ridge. **Male, 16:** I didn't know what that was, then I learned from it.
- **Male, 13:** The ridge. **Adult Female:** But as you kept going you got it. **Male, 13:** But on the third one it was hard because #1 (the puma) has a pointed ridge, but this one I didn't even see it.
- **Adult Female:** What's a ridge? What is it? It was hard to tell.
- **Male, 14:** Eye placement.
- **Female, 12:** Because I haven't looked at skulls like this. **Female, 10:** But it was fun to learn. The teeth were challenging.

Disrupt



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Disrupt Takeaways

- **It's messy!**
- We can **elicit disequilibrium** by breaking the rules and introducing unfamiliar information
- **Persistence can be heightened** by raising the stakes with asking for initial guesses
- **Learn from visitors' natural behavior** to craft hard, believable choices
- **Productivity can be enhanced** by increasing disequilibrium

Support

Do as many as possible:

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Encourage trying again

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Support self-regulation

Acknowledge the challenge

Normalize feelings of disequilibrium

Invite reflection on disequilibrium

1.

There is a better answer.

Take another look

Try again

The eye sockets are highlighted in blue.



Try again

2.

There is a better answer.

Learn more about eyes

Try again

There is a better answer.

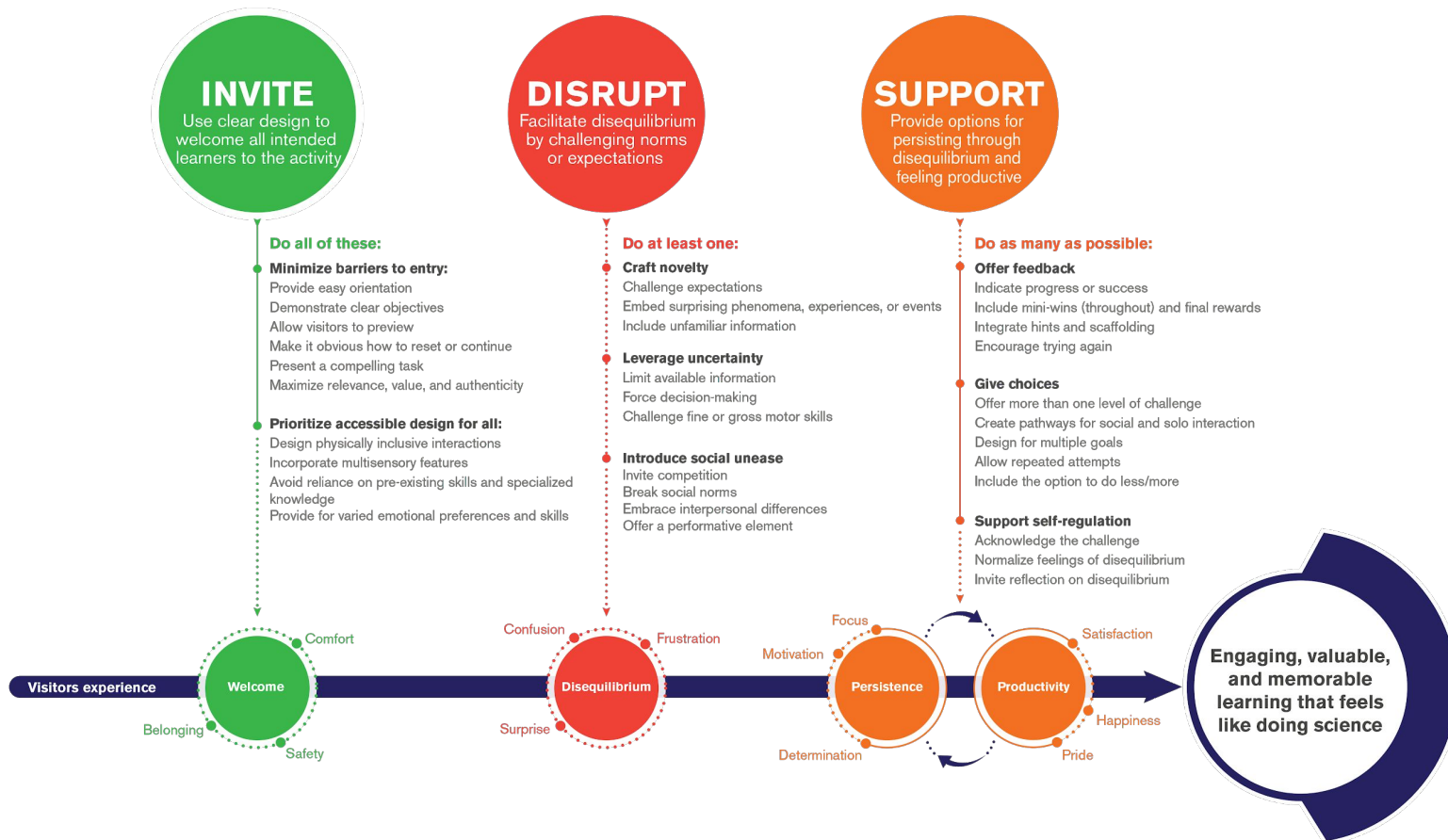
Prey animals have eyes on the sides of their head which allows them to see more of their surroundings and watch for possible predators.



Deer are prey animals with side-facing eyes.

Try again

Designing for Productive Struggle



Support

Do as many as possible:

Offer feedback

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Support self-regulation

- Acknowledge the challenge
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- Invite reflection on disequilibrium

**We are still learning and exploring.
This framework can still evolve.**

**It's important to use mixed-methods
when evaluating productive struggle.**

High-impact \neq High-complexity



=





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THANK YOU!