Overview
● ● ● ●

2

Research Data Archive (RDA)

Website that hosts 900+ publicly-available datasets

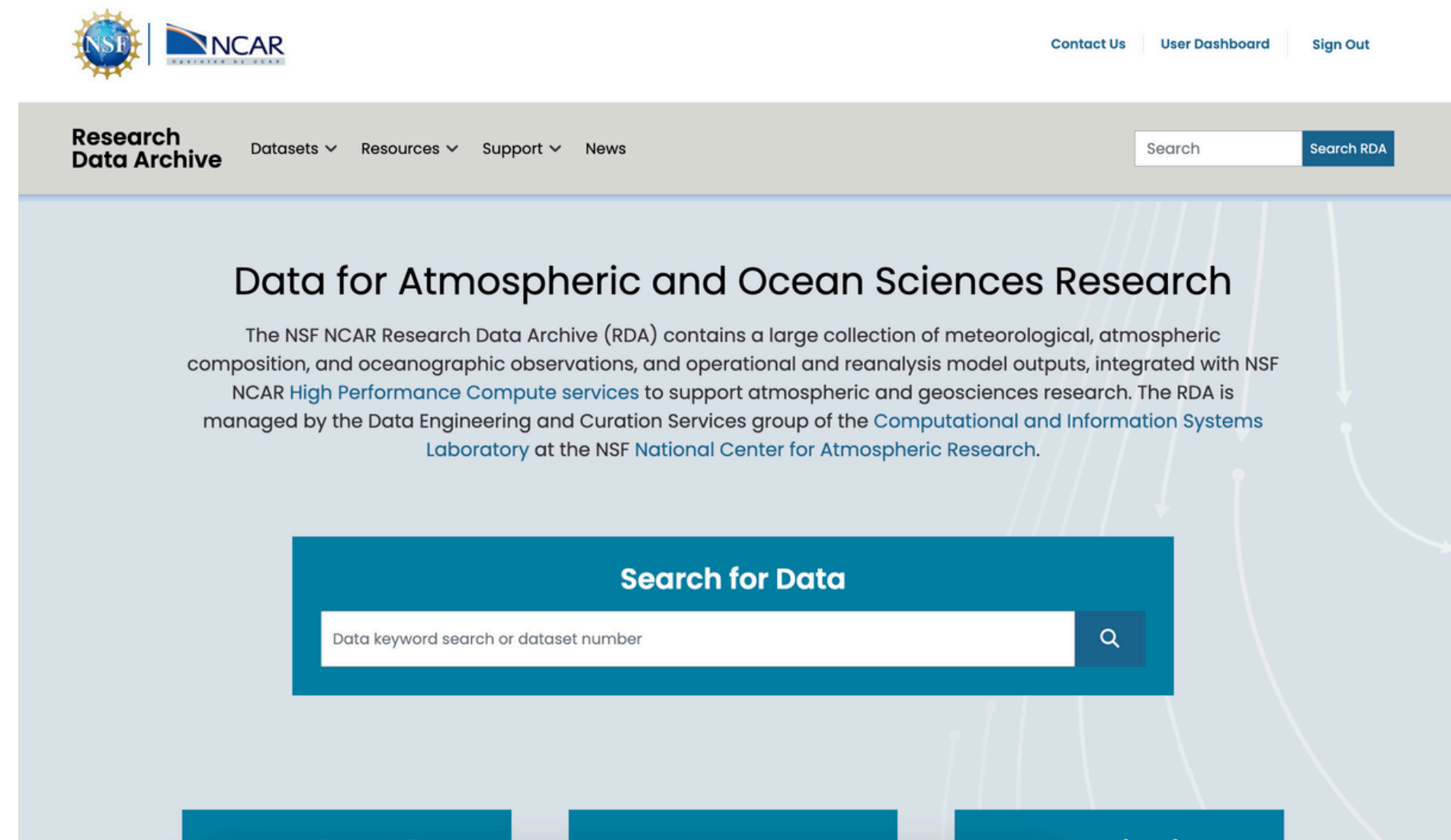Managed by the Data Engineering and Curation Section (DECS) team

Serves tens of thousands of users worldwide

Offers services to help users navigate and utilize large, complex datasets for modeling, analysis, policy, and more

Are users satisfied with how they access data from the RDA?

Are users satisfied with how they access data from the RDA?

RDA Helpdesk Portal

Users can submit requests for support and submit a ticket.

Support Email

Directly reach a member of the DECS team via rdahelp@ucar.edu.

Are users satisfied with how they access data from the RDA?

RDA Helpdesk Portal

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Support Email

Directly reach a member of the DECS team via rdahelp@ucar.edu.

Not intended for user feedback

No structure for intentionally collecting, analyzing, or incorporating feedback from users.

Are users satisfied with how they access data from the RDA?
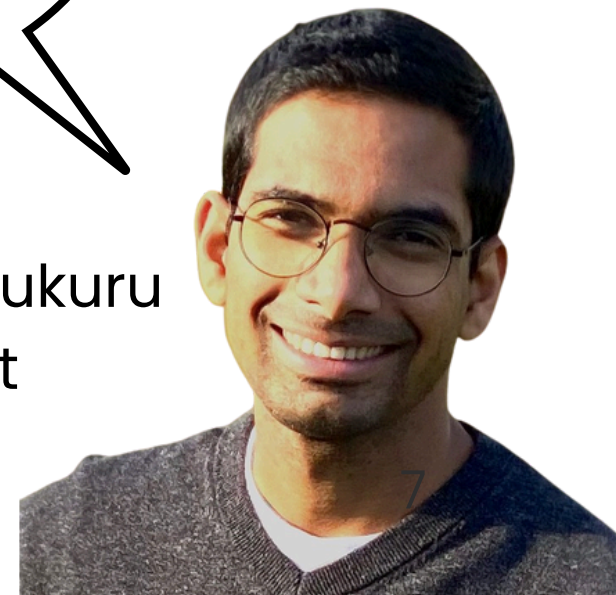
How might we systematically improve the user experience of the RDA?
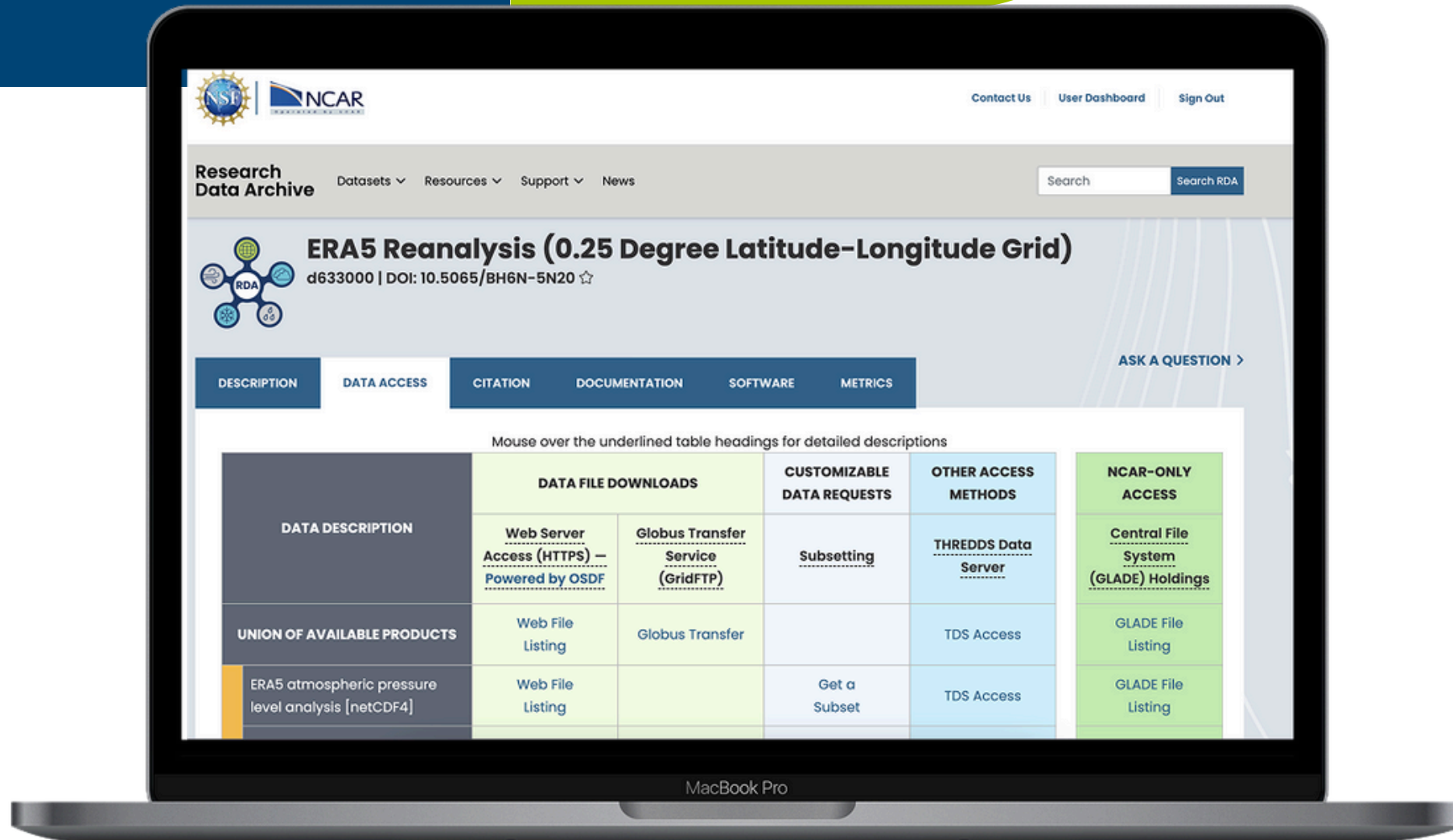
What is User Experience (UX) Research?

"The **systematic study of target users and their requirements**, to add realistic contexts and insights to design processes"

UX research & design come from **human-computer interaction (HCI)**

HCI is a **multidisciplinary field** that blends together:
- Computer Science & Engineering
- Cognitive Science
- Art & Product Design
- (and more)

Interaction Design Foundation 2025; Grudin 2017
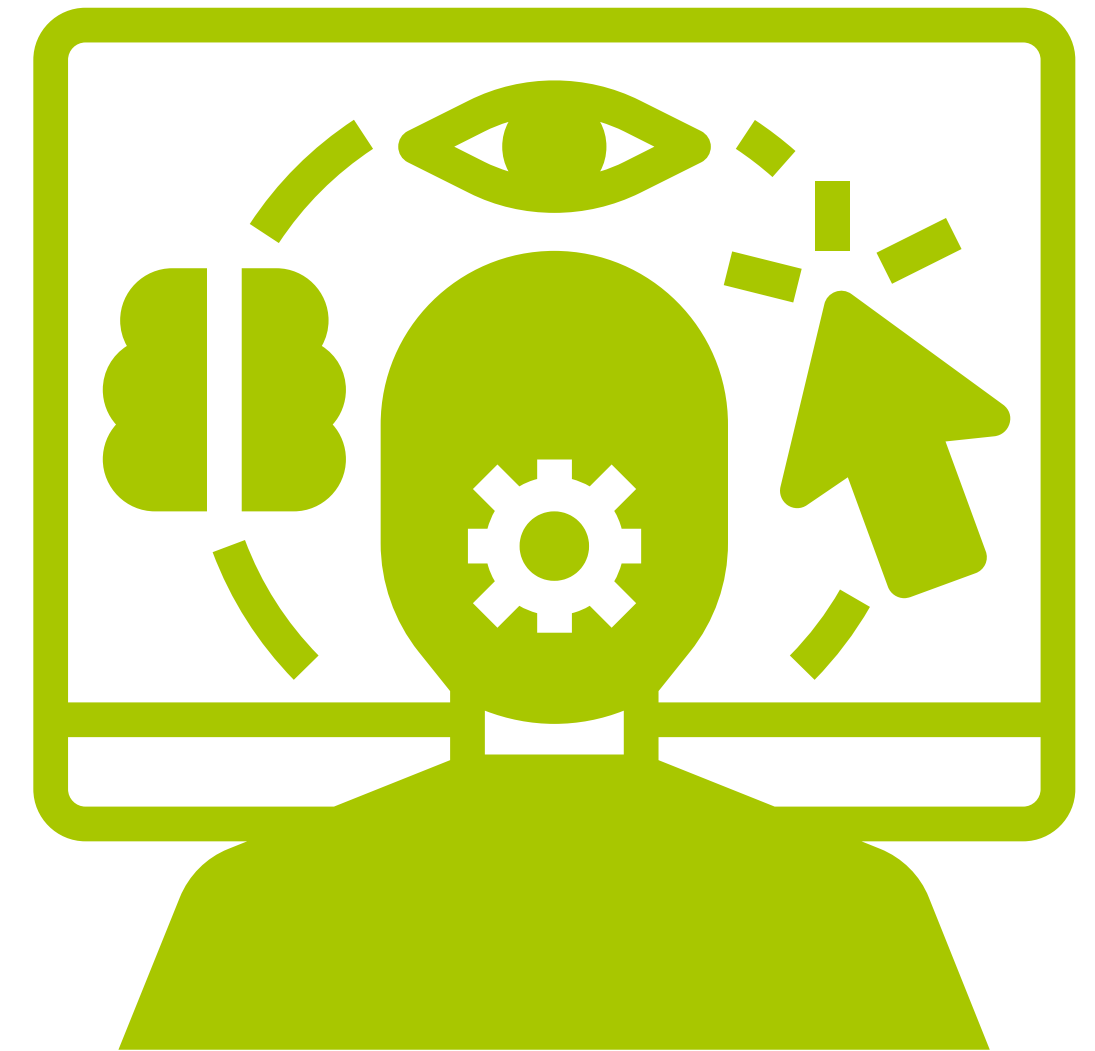
Iterative Design Thinking **Approach**
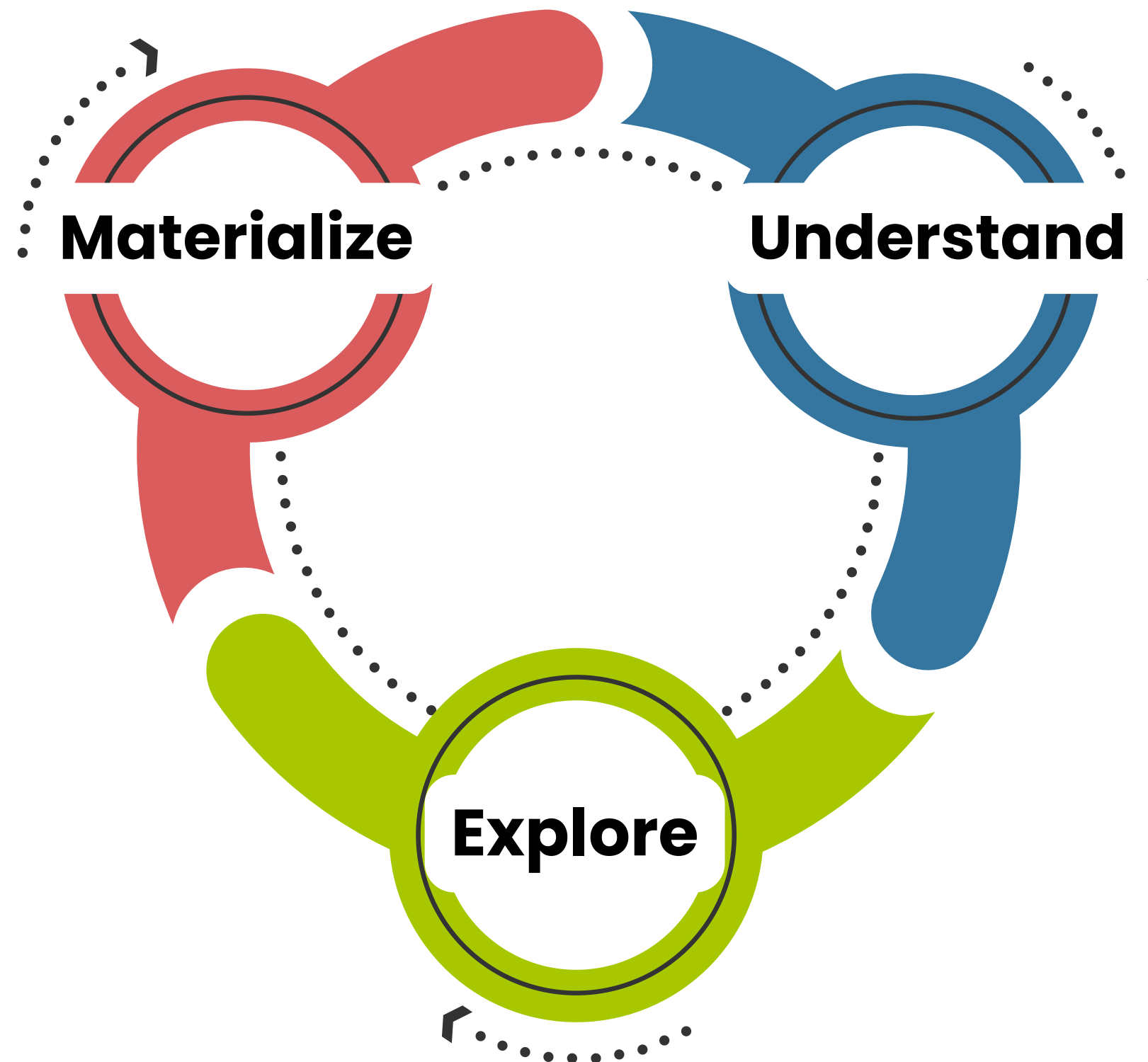
"A human-centered framework for ideation by integrating the needs of people, the possibilities of technology, and the requirements for business success."

3 primary phases:

- **UNDERSTAND** users, needs, problem context
- **EXPLORE** ideas & solutions based on needs
- **MATERIALIZE** by testing ideas with users and, if successful, moving to production

Iterative Design Thinking **Approach**

Materialize

Understand

Explore
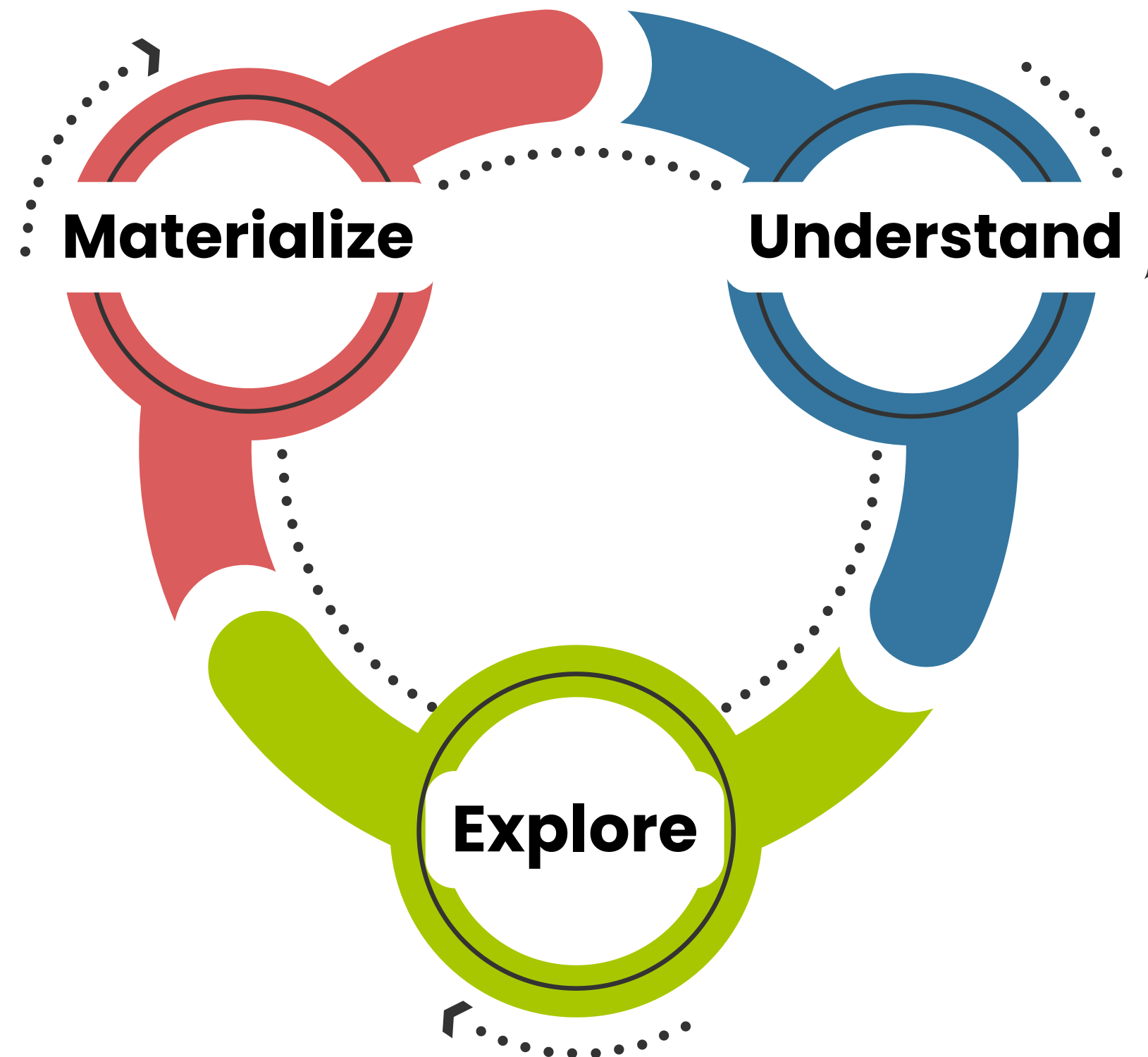
- Each phase builds upon insights from the previous phase

- Aligns deliverables with evidence of users' needs & experiences

- Strengthens agile product development
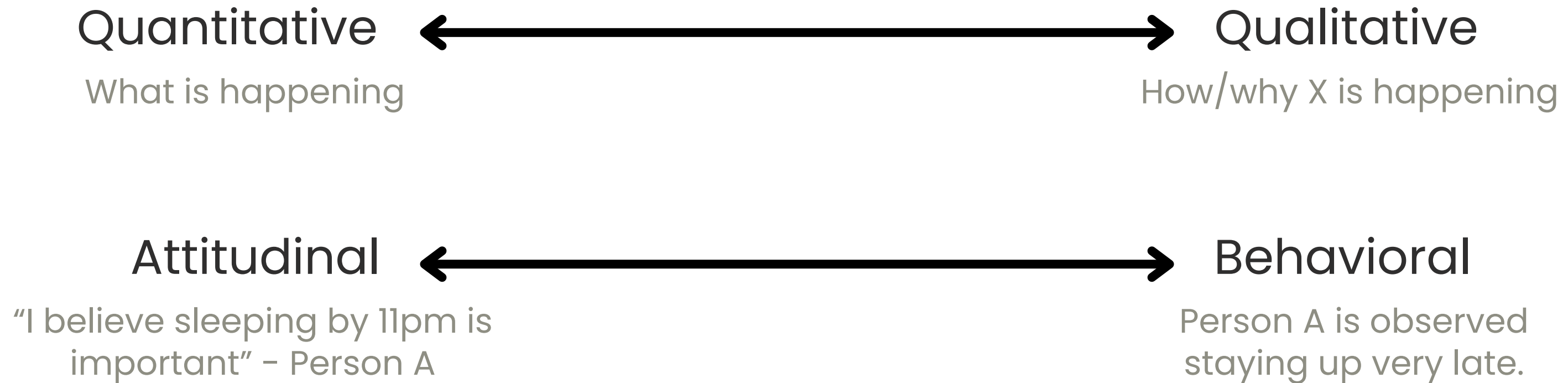
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Interaction Design Foundation 2025 ; Gibbons 2016 (NN/g); Loranger & Laubheimer 2017 (NN/g)

UX Research **Methods**

Quantitative ⟷ Qualitative

What is happening How/why X is happening

Interaction Design Foundation 2025; Martin & Hanington 2012

UX Research **Methods**

Quantitative ⟷ Qualitative

What is happening

How/why X is happening

Attitudinal ⟷ Behavioral

"I believe sleeping by 11pm is important" – Person A

Person A is observed staying up very late.

Interaction Design Foundation 2025; Martin & Hanington 2012

UX Research **Methods**

Quantitative ←————————————————→ Qualitative

What is happening   How/why X is happening

Attitudinal ←————————————————→ Behavioral

"I believe sleeping by 11pm is important" – Person A   Person A is observed staying up very late.

Generative ←————————————————→ Evaluative

"Generating" understanding of users to motivate ideas/solutions   "Evaluating" those ideas/solutions for usability and alignment with user needs

Interaction Design Foundation 2025; Martin & Hanington 2012

UX Research **Methods**

Example: **Interviews** are often...

Quantitative ⟵————————————⟶ Qualitative

What is happening

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UX Research **Methods**

Example: Surveys are often...

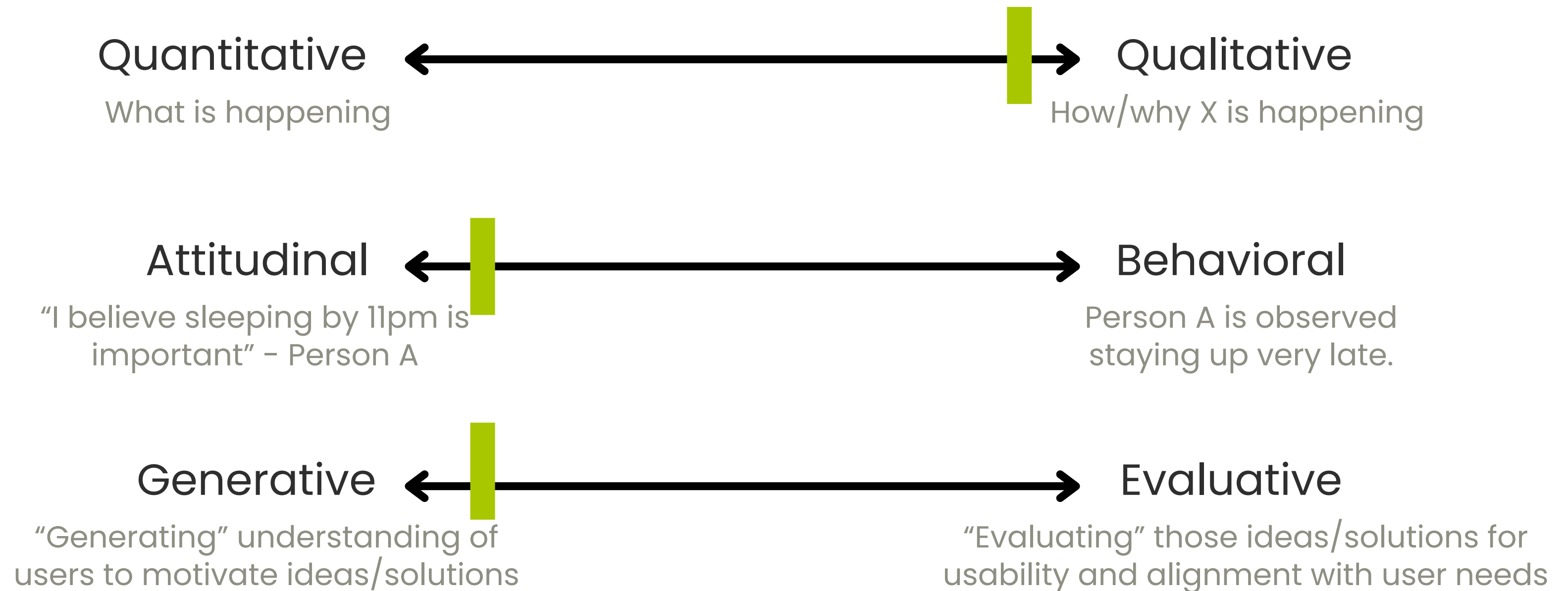How you use a method can depend on **what** phase **you're in!**

Quantitative ⟷ Qualitative

What is happening

How/why X is happening

Attitudinal ⟷ Behavioral

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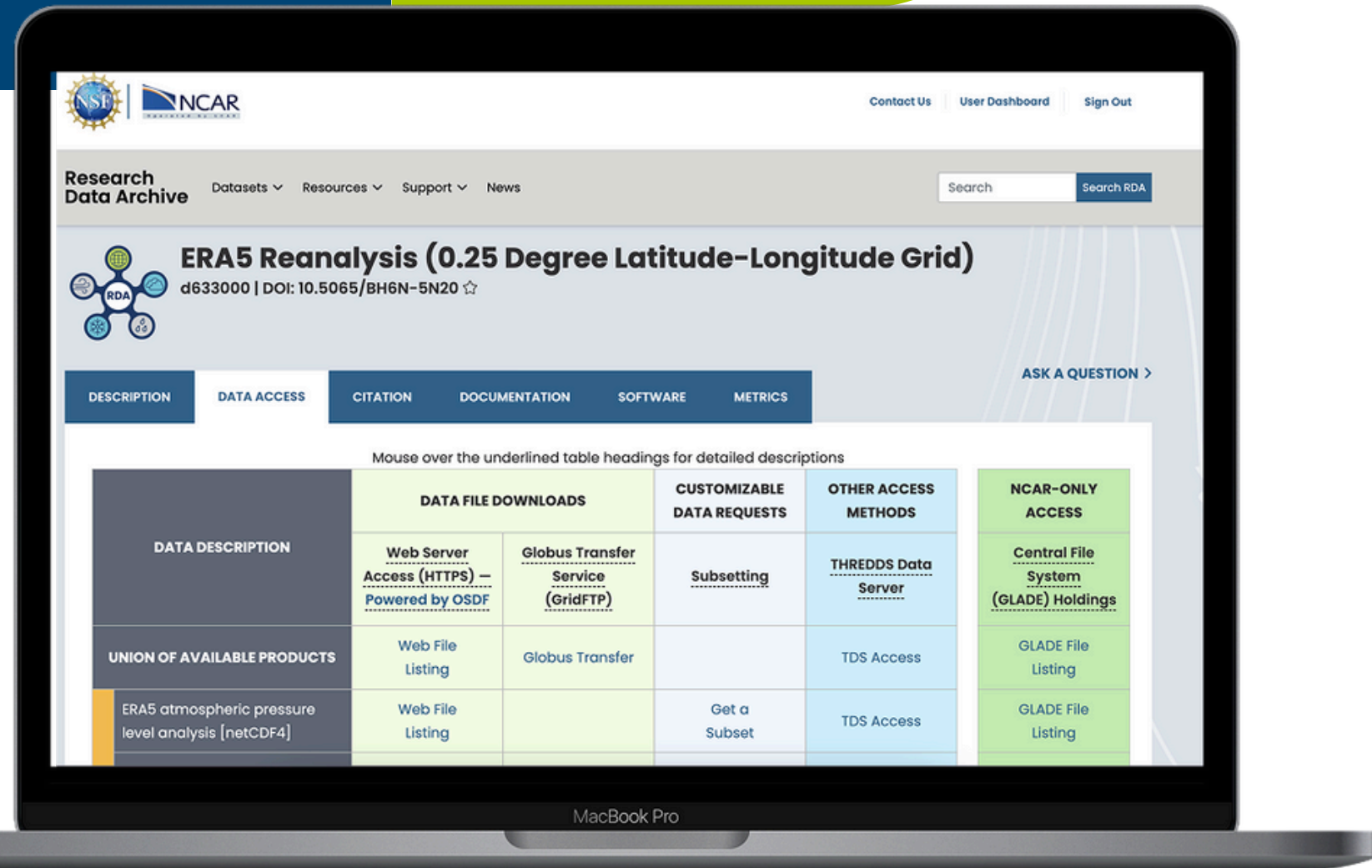Interaction Design Foundation 2025; Martin & Hanington 2012

Scope of Internship

Focus on the web-based interface for **Data Access tab** on the RDA

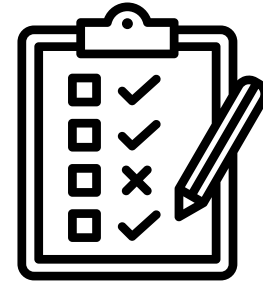Prioritize **NCAR staff** and **NCAR-affiliated users** with access to GLADE

Engage **directly with users** to **complement existing** metrics & methods of understanding users

Demonstrate **how to use UX research through real-world case study** of working with the RDA
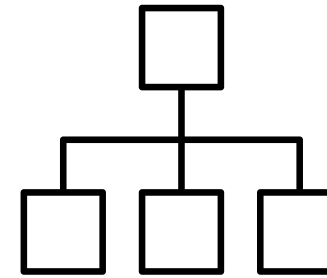
Overview of Internship Work

Understand Phase

Usability Heuristic Evaluation

Evaluated current usability of RDA's Data Access screens

Qual/Mixed - Evaluative

Click / User Task Analysis Flow

Diagramed user's interactions & decisions within current UI

Qual/Mixed - Evaluative

Demographic & Feedback Survey

Captured who users are and their initial feedback of the RDA

Mixed – Generative – Attitudinal

Interviews & Usability Sessions

Engaged & observed users & recorded system usability survey (SUS)

Mixed – Generative – Attitudinal & Behavioral

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Overview of Internship Work

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Qual/Mixed - Evaluative

Click / User Task Analysis Flow

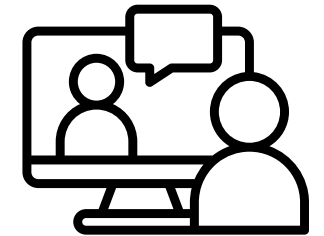Diagramed user's interactions & decisions within current UI

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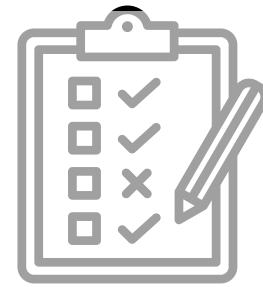
Mixed – Generative – Attitudinal

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Mixed – Generative – Attitudinal & Behavioral

Explore Phase

Group Lightning Sketches

Team sketched several redesign ideas based on user feedback

Using Miro

Med–High Fidelity Prototypes

Created several static layouts & interactive designs

Using Figma
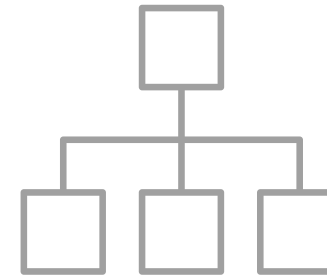
19

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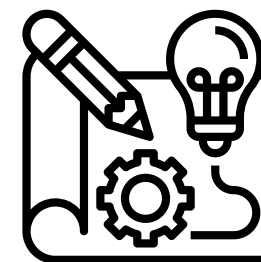Mixed – Generative – Attitudinal & Behavioral

Explore Phase

Group Lightning Sketches

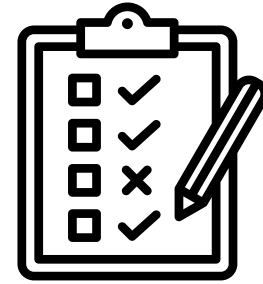Team sketched several redesign ideas based on user feedback

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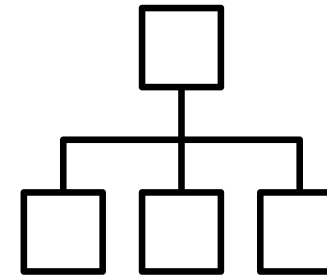Created several static layouts & interactive designs

Using Figma

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Usability Heuristic Evaluation

Method for **evaluating problems in an interface** with Jakob Nielsen's 10 Usability Heuristics

Visibility of System Status **1**	Match Between System & Real World **2**	User Control And Freedom **3**	Consistency And Standards **4**	Error Prevention **5**
Recognition Rather Than Recall **6**	Flexibility And Efficiency of Use **7**	Aesthetic And Minimalististic Design **8**	Help Users With Errors **9**	Help And Documentation **10**
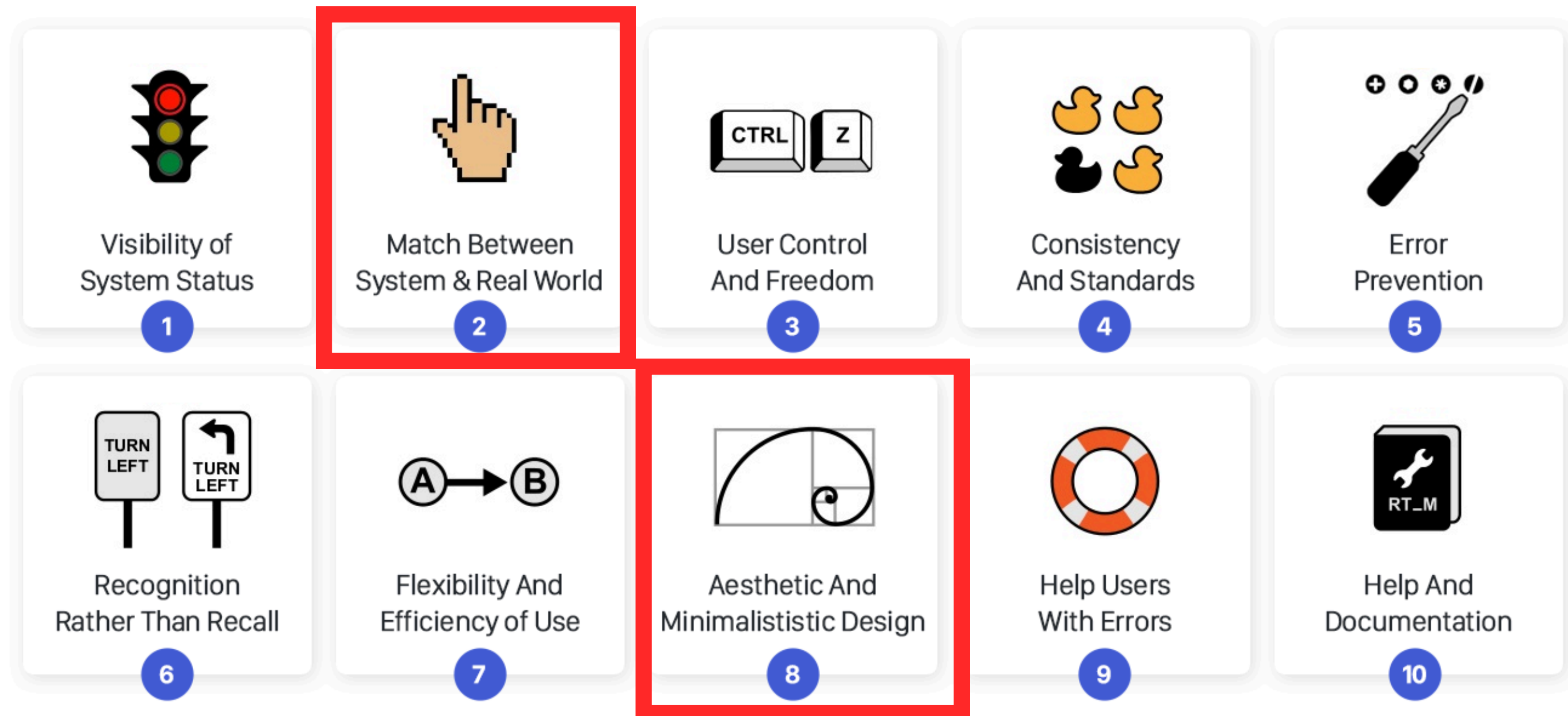
Usability Heuristic Evaluation

Method for **evaluating problems in an interface** utilizing Jakob Nielsen's 10 Usability Heuristics

Grounded in the "understanding of human **behavior**, **psychology**, and **information processing**" + domain-specific norms

- Use Miro (online, collaborative whiteboarding tool)

- Annotate screenshots of the Data Access portion of RDA with issues based on the 10 usability heuristics
  - Brief explanation (and optional fix)
- Count the # of issues in each category

Nielsen 1994 (NNGroup)

ERA5 Reanalysis (0.25 Degree Latitude-Longitude Grid)

d633000 | DOI: 10.5065/BH6N-5N20 ☆

ASK A QUESTION >

| DESCRIPTION | **DATA ACCESS** | CITATION | DOCUMENTATION | SOFTWARE | METRICS |

Mouse over the underlined table headings for detailed descriptions

DATA DESCRIPTION	DATA FILE DOWNLOADS		CUSTOMIZABLE DATA REQUESTS	OTHER ACCESS METHODS	NCAR-ONLY ACCESS
	Web Server Access (HTTPS) — Powered by OSDF	Globus Transfer Service (GridFTP)	Subsetting	THREDDS Data Server	Central File System (GLADE) Holdings
UNION OF AVAILABLE PRODUCTS	Web File Listing	Globus Transfer		TDS Access	GLADE File Listing
ERA5 atmospheric pressure level analysis [netCDF4]	Web File Listing		Get a Subset	TDS Access	GLADE File Listing
ERA5 atmospheric surface analysis [netCDF4]	Web File Listing		Get a Subset	TDS Access	GLADE File Listing
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ERA5 atmospheric surface forecast (accumulated) [netCDF4]	Web File Listing		Get a Subset	TDS Access	GLADE File Listing
ERA5 atmospheric surface	Web File		Get a		GLADE File

23

ERA5 Reanalysis (0.25 Degree Latitude-Longitude Grid)

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[2] "Union" & "Products" terms unfamiliar to users

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24

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[2] "Union" & "Products" terms unfamiliar to users

[8] Redudant info in every row = overwhelming

| DESCRIPTION | DATA ACCESS | CITATION | DOCUMENTATION | SOFTWARE | METRICS |

ASK A QUEST...

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ERA5 atmospheric surface forecast (accumulated) [netCDF4]	Web File Listing		Get a Subset	TDS Access	GLADE File Listing
ERA5 atmospheric surface					

**[8] Do all these colors mean something?**

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Interviews & Usability Sessions

A **combination** of semi-structured interviews and usability sessions

Goal is to understand **how users feel about the RDA** (attitudinal) **& how users navigate the RDA website** (behavioral)

- Recruited via survey;
- 6 participants with varying familiarity with the RDA
    - 4 NCAR staff
    - 2 affiliated researchers
- 30-45min sessions via Zoom
- Given a task to customize a subset of the ERA5 Reanalysis dataset & verbalize their process
- **Post-task, completed a System Usability Survey (SUS)**

Interaction Design Foundation n.d. ; Brooke 1996

What recommendations do we have from using these methods in the Understand Phase?
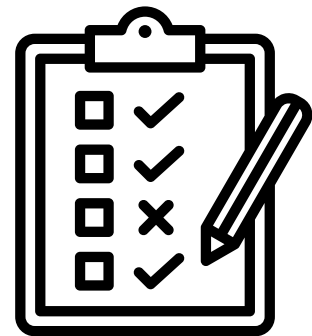
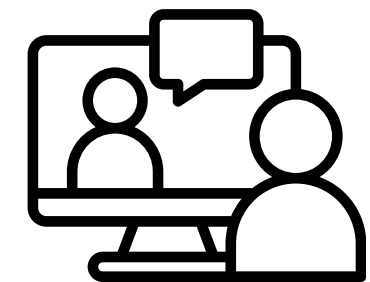**Usability Heuristic Evaluation**
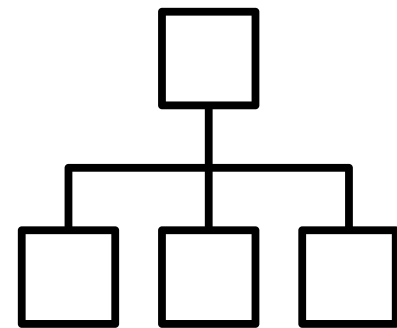
Click / User Task Analysis Flow

Demographic & Feedback Survey

Interviews & Usability Sessions

Design Recommendations

1. Streamlining the customizable data (subset) service

2. Improve information architecture to align with users' mental models

3. Align more with users' existing workflows

4. Minor user interface (UI) changes for standard usability

Design Recommendations

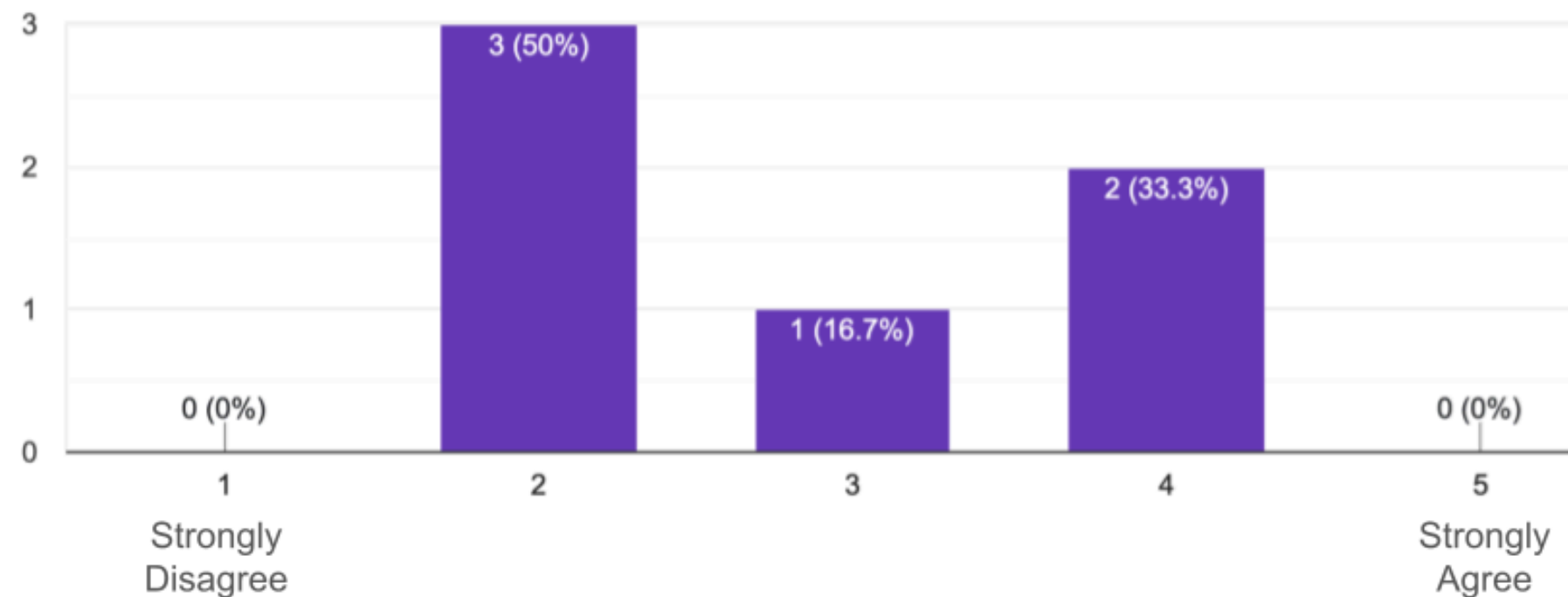**1. Streamlining the customizable data (subset) service**

- <u>Heuristic Evaluation</u>: Issues with #8 aesthetic/minimialistic design, #2 match between system & real-world, #3 user control & freedom
- <u>Click/Task Flow</u>: Repetitive flows across services in data access, but unclear how or why they are the same

Design Recommendations

Streamlining the customizable data (subset) service – System Usability Score (SUS) & Survey

I found the Data Access tab unnecessarily complex.

6 responses

*"I didn't have a great handle on **why there were so many different data access options available**, and **it was overwhelming** the first time I interacted with a database"*

– Survey response #12

Design Recommendations

Streamlining the customizable data (subset) service – SUS and Usability Session

I found the Data Access tab unnecessarily complex.

6 responses

I felt very confident using the Data Access tab.

6 responses

*"I didn't have a great handle on **why there were so many different data access options available**, and **it was overwhelming** the first time I interacted with a database"*
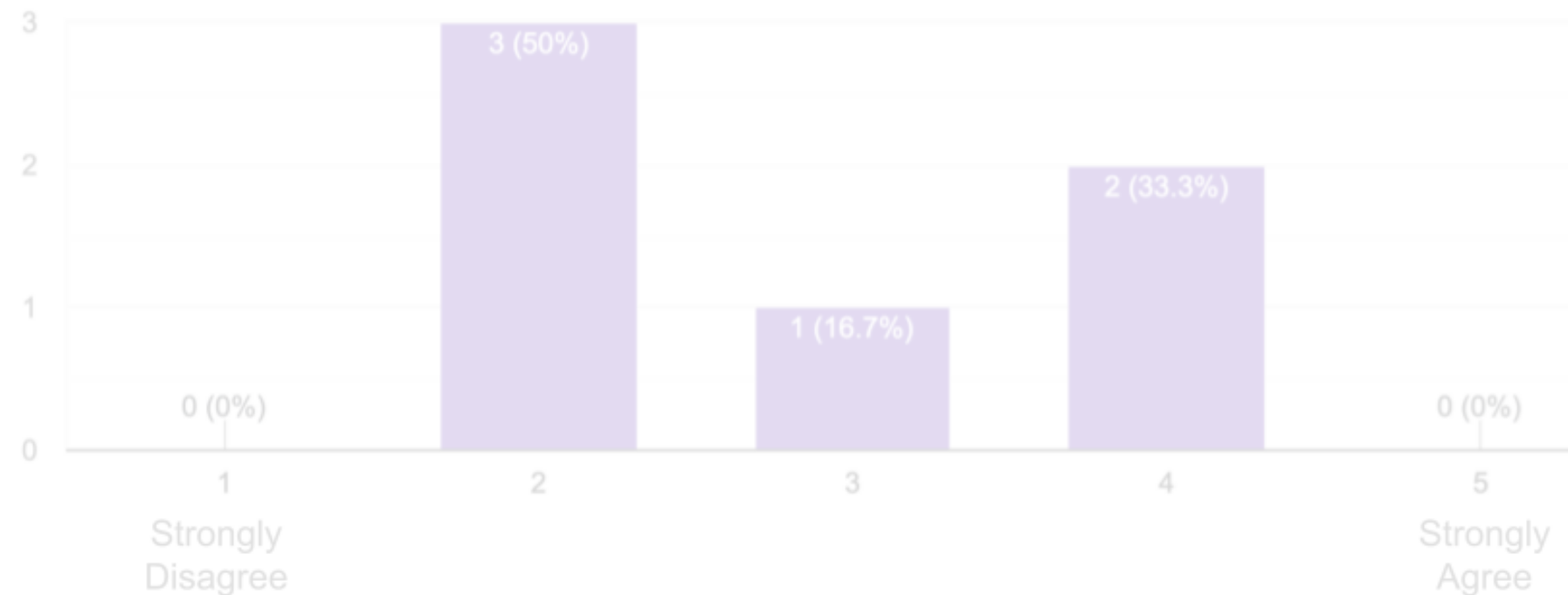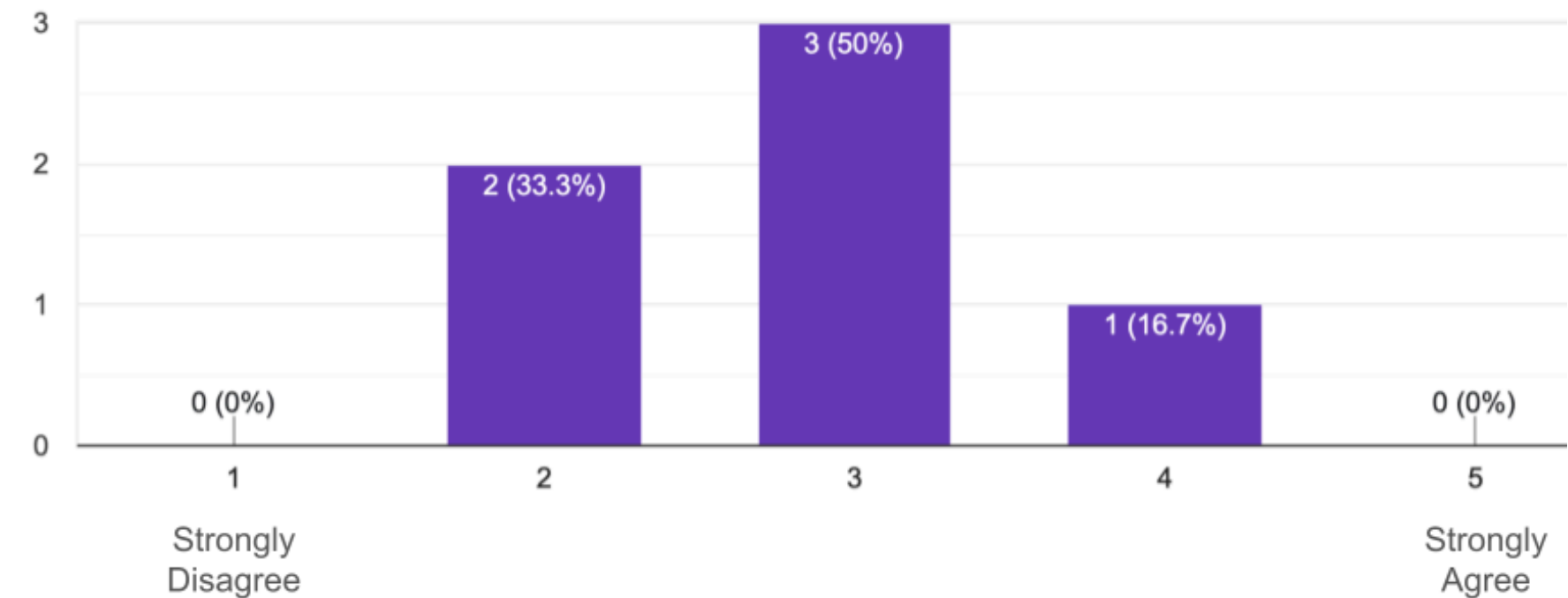– Survey response #12

*"**I'm not really sure what I was doing** […] It **looked like the same screen** as when I clicked on subsetting"*
– Session participant #2, expressing confusion

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Impact-Effort Matrix

Strategy to help visualize what **ideas are desirable** and what to **prioritize**.

1. Streamlining the customizable data (subset) service

2. Improve information architecture to align with users' mental models

3. Align better & work within users' existing workflows

4. Minor UI improvements

Gibbons 2021 (NN/g); Gibbons 2018 (NN/g); Miro article & template

Value to users

QUICK WINS
Low effort,
High value

BIG BETS
High effort,
High value

FILL-INS
Low effort,
Low value

MONEY PIT
High effort,
Low value

Effort to implement by organization
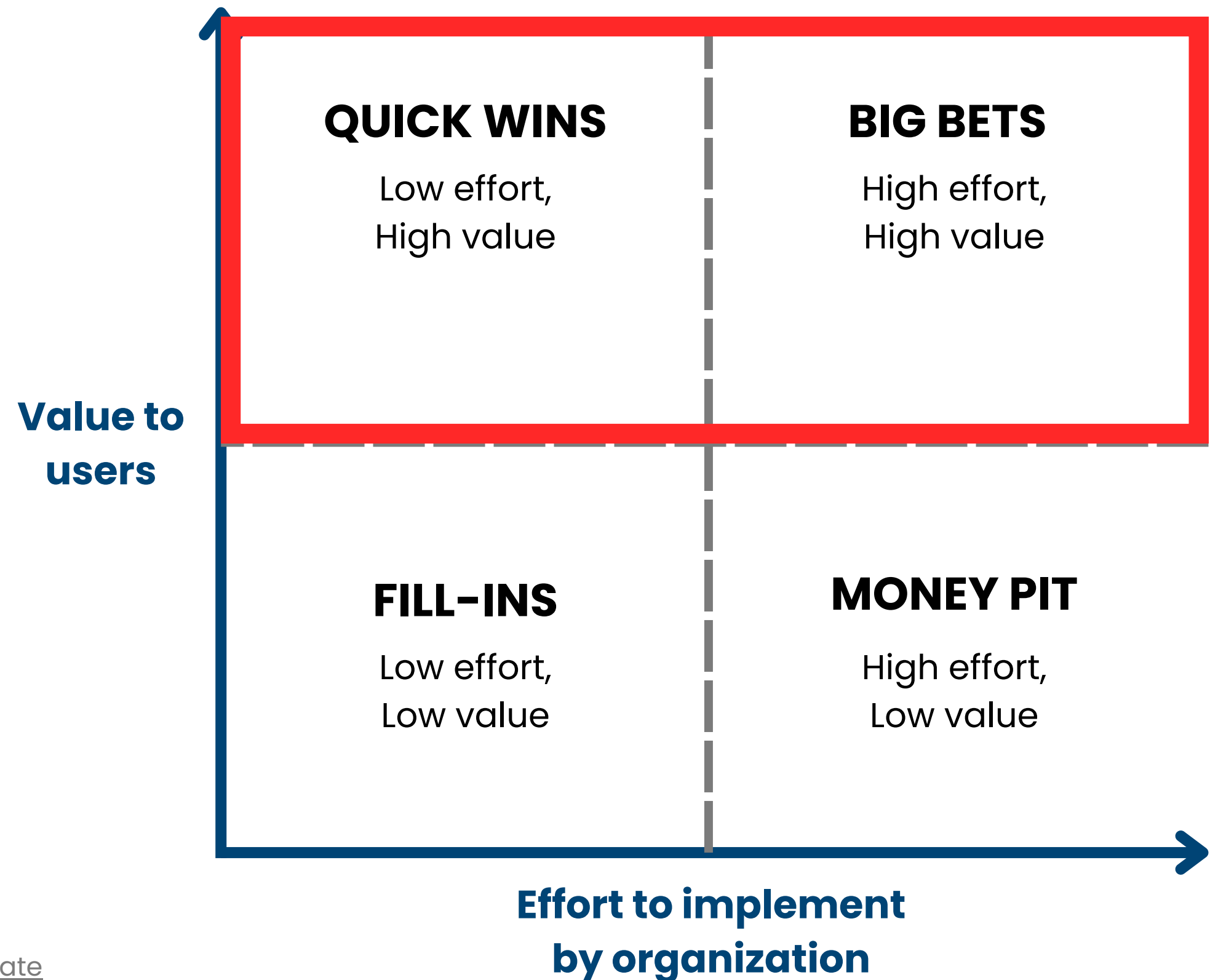
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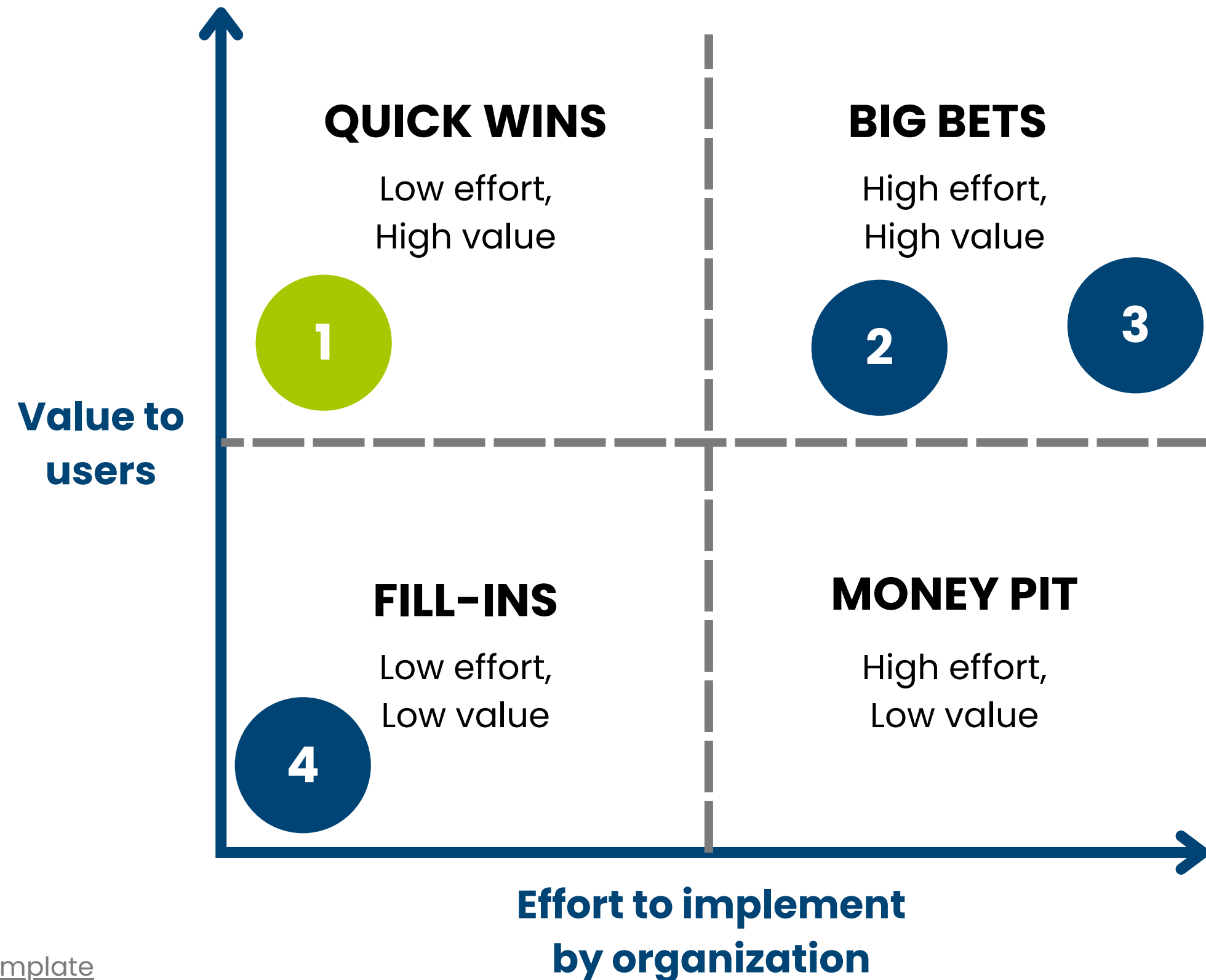**Value to users**

Effort to implement by organization

QUICK WINS
Low effort, High value

1

BIG BETS
High effort, High value

2 **3**

FILL-INS
Low effort, Low value

4

MONEY PIT
High effort, Low value

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DESCRIPTION | **DATA ACCESS** | **CITATION** | **DOCUMENTATION** | **SOFTWARE** | **METRICS**

Overview ︿

Types of data
- Grid

Format of data
- netCDF4

Total volume: 710.25 TB

Organization of dataset
- 8 groups

Subset service available
- All 8 groups
- Entire dataset

Number of variables: 46

Available data access methods
- Web server (HTTPS through Open Science Data Federation)
- Globus (GridFTP)
- THREDDS Data Server
- GLADE (NCAR-only access)

For more details, please see Documentation or Metadata Summary.

Get a subset

From the entire dataset (if available) or one specific grouping of the dataset, provide your desired temporal, parameter, and spatial selections and access method for your customized subset of the data.

Your Subset Selections: | ✕ ERA5 atmospheric surface analysis [netCDF4] | ✕ 1940-01-01 (00:00) to 2025-01-01 (00:00) | ✕ 2 metre temperature

No Spatial Selection specified | No Access Method specified

Group

Temporal Selection

Parameter Selection

Spatial Selection

Access Method

☐ 10 metre U wind component
☐ 10 metre V wind component
☐ 10 metre wind gust since previous post-processing
☐ 100 metre U wind component
☐ 100 metre V wind component
☐ 2 metre dewpoint temperature
☑ 2 metre temperature
☐ Angle of sub-gridscale orography
☐ Anisotrophy of sub-gridscale orography
☐ Boundary layer dissipation
☐ Boundary layer height
☐ Charnock
☐ Clear-sky direct solar radiation at surface
☐ Cloud base height
☐ Cloud cover

☐ Neutral wind at 10m V-component
☐ Northward gravity wave surface stress
☐ Northward turbulent surface stress
☐ Ozone mass mixing ratio
☐ Potential evaporation
☐ Potential vorticity
☐ Relative humidity
☐ Runoff
☐ Sea surface temperature
☐ Sea-ice cover
☐ Skin reservoir content
☐ Skin temperature
☐ Slope of sub-gridscale orography
☐ Snow albedo
☐ Snow density

1. "Subset" service is clear.

3. Display user's selections at all times

2. Allow users to freely customize their selections

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DESCRIPTION   **DATA ACCESS**   **CITATION**   **DOCUMENTATION**   **SOFTWARE**   **METRICS**

Get a Subset

From the entire dataset (if available) or one specific grouping of the dataset, select your desired temporal, variables, spatial parameters, and access method for your customized subset of data.

Your Selection

Subset Group
Variables
Temporal Range
Spatial Range
Data Access Method

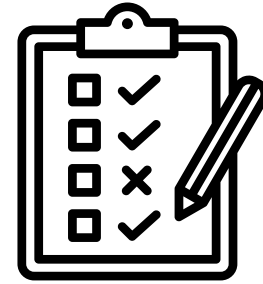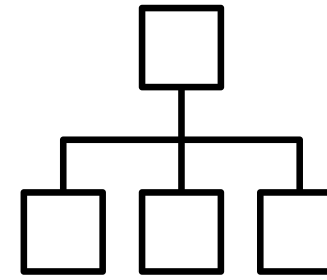| Select to subset from...	^
Entire dataset (all groups)	
ERA5 atmospheric pressure level analysis [netCDF4]	>
ERA5 atmospheric surface analysis [netCDF4]	>
ERA5 atmospheric vertical integrals (ECMWF Table 162) [netCDF4]	>
ERA5 atmospheric surface forecast (accumulated) [netCDF4]	>
ERA5 atmospheric surface forecast (instantaneous) [netCDF4]	>
ERA5 atmospheric surface forecast (mean rates or fluxes) [netCDF4]	>
ERA5 atmospheric surface forecast (minimum-maximum) [netCDF4]	>

Overview of Internship Work

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Qual/Mixed - Evaluative

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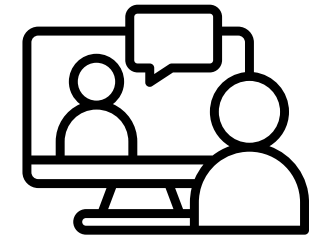Diagramed user's interactions & decisions within current UI

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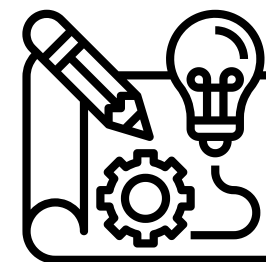Mixed – Generative – Attitudinal & Behavioral

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Using Miro

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Created several static layouts & interactive designs

Using Figma

Post-internship →

Materialize Phase

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Future Work

Proceed with "Materialize" phase and show a variety of prototypes to users for feedback

Revisit "Understand" phase with more users (larger sample size)

Further explore specific needs such as GLADE access, tutorials/walkthroughs, and new data access methods (ARCO, Zarr, catalogues)
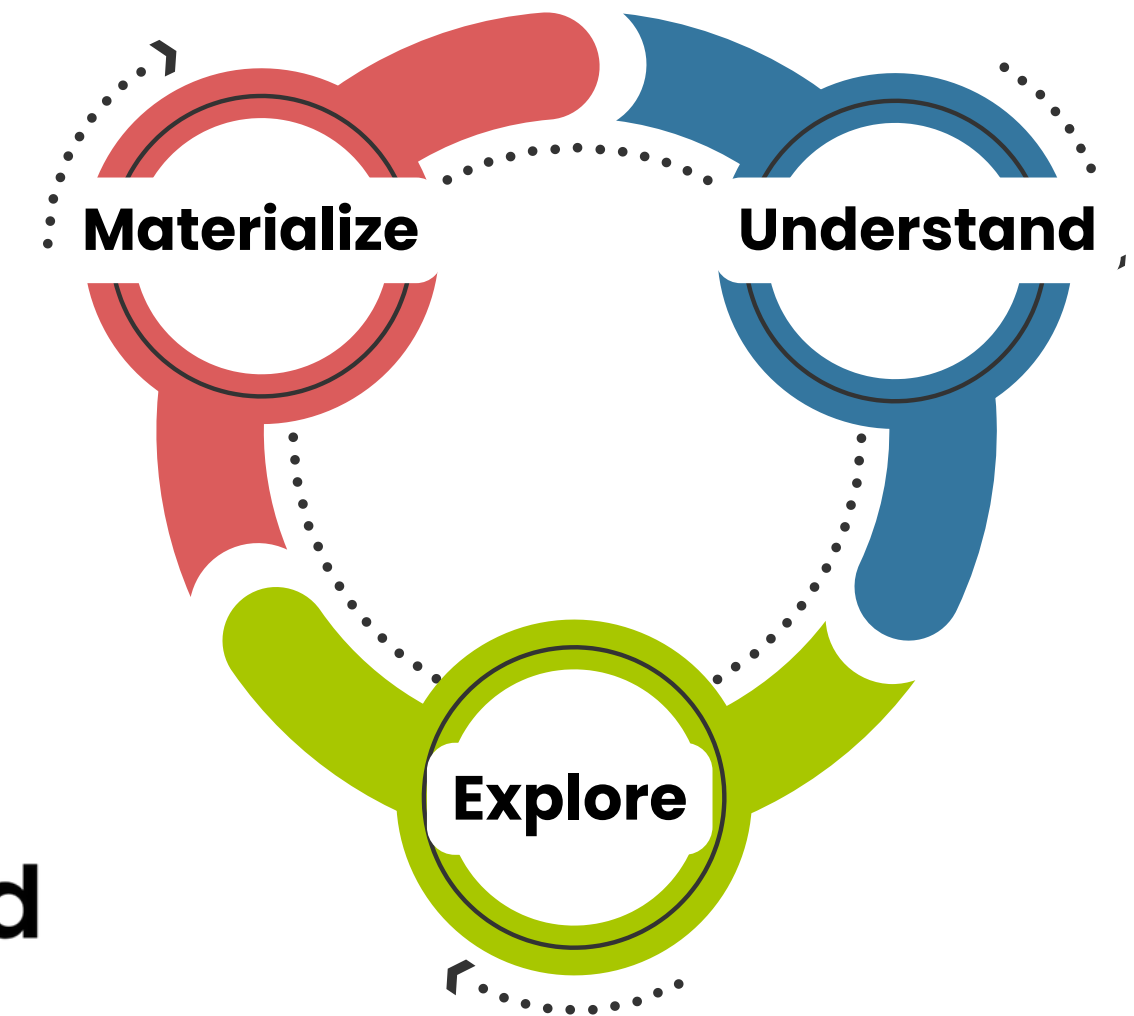
Leverage UX research for other services at NCAR (e.g., Data Commons Initiative)

User Experience Research to systematically improve the RDA

Reach out to my mentors for the full report and **join the NCAR UX Community of Practice**!

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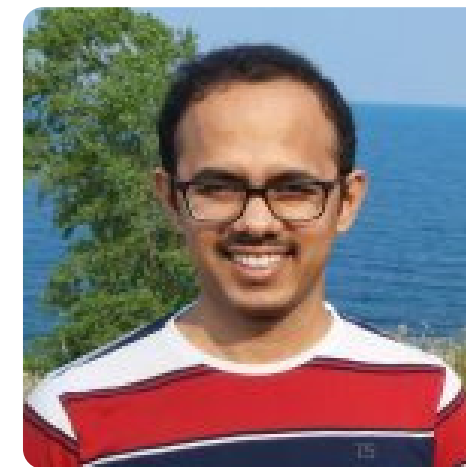🌐 conniewchau.me

Materialize

Understand

Explore

User Centered Science Collective

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Thank you to our summer project team, our participants, & SIParCS!

Minh Le

Riley Conroy

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Nihanth Cherukuru

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