Improving the Accessibility of Graphs for Users who are Blind

TEAM CANE

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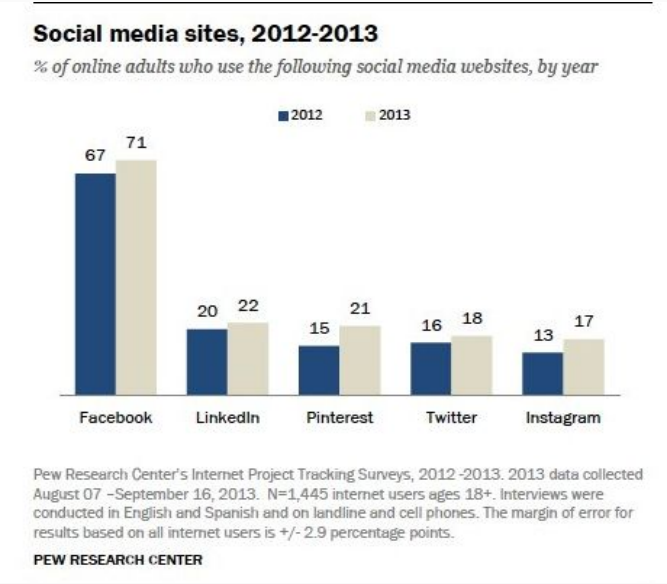
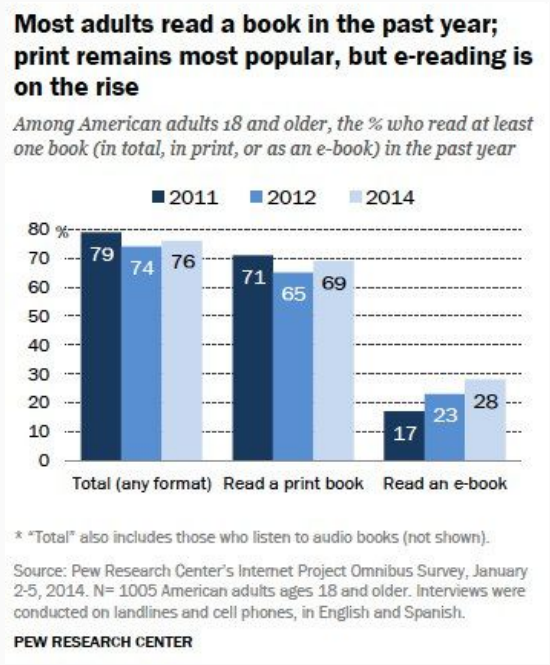
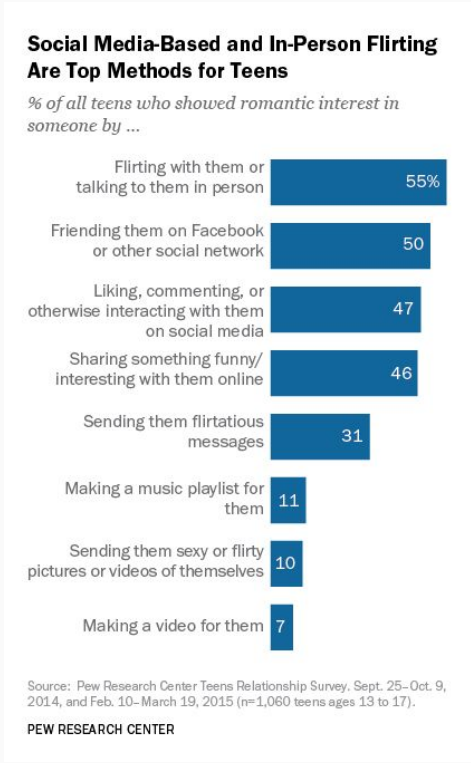
Graphs are a common way of disseminating information to the public.

Common Graphs



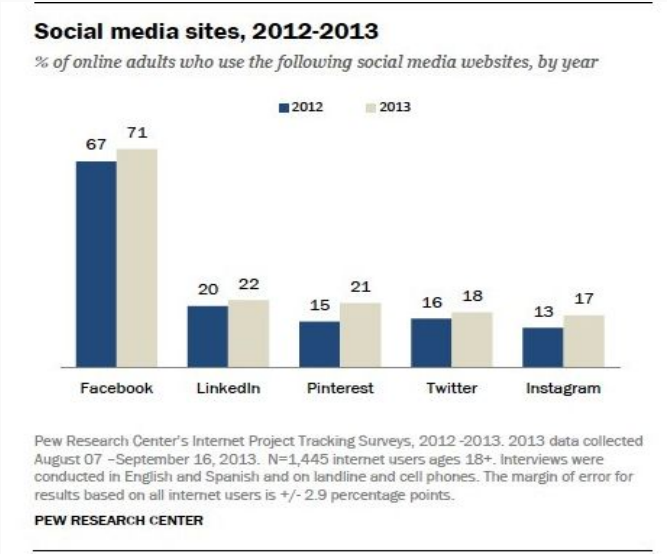


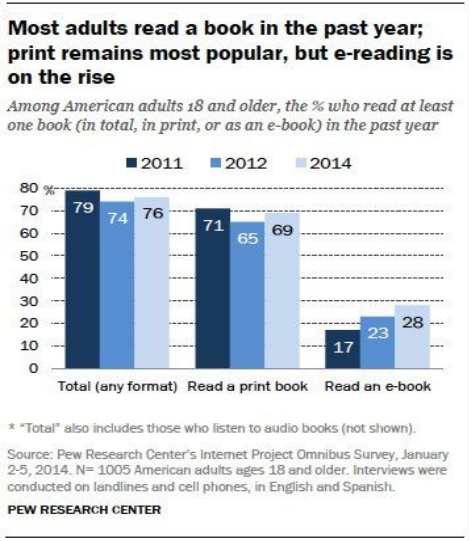


Source: http://www.pewinternet.org/

Understanding Graphs

1. Perceive the data
2. Distinguish multiple groups of data (e.g., lines on a line graph)
3. Extract comparisons
4. Have a sense of the display area
5. Notice any important aspects of the data such as inflection points, intersections, axes, and origins





Our Questions

1. How do users who are blind currently interact with graphs?

2. What challenges do users who are blind currently face when encountering graphs?

Unfortunately, over the years, I've always found that whichever operating system I'm using, whether it's on a PC or on a Mac, the most detail I get is the screenreader letting me know that there is a graph on the screen. That's the extent of it. So usually I end up skipping those graphs because very often there isn't any more detail than just "graph."

Carl

Current Solutions

Figure 3. A user interacting with the prototype interface. Input is controlled via the graphics tablet with the dominant hand, while the non-dominant hand receives tactile feedback.

Yu, W., Brewster, S. (2003). Evaluation of multimodal graphs for blind people. Universal Access in the Information Society, 105-124.

Wall, S. & Brewster, S., (2006). Feeling what you hear: tactile feedback for navigation of audio graphs. Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '06), 1123-1132.

Final Question

How can we improve **written descriptions** and develop **guidelines** for web developers and designers when presenting graphs in web-based technologies for screen readers?

METHODS

Participants

- Live in Chicago
- Blind
- Familiar with common web & accessibility technologies
- General understanding of bar & line graphs

Pseudonym	Age	Gender
Anna	66	Female
Betty	26	Female
Carl	38	Male
Denise	67	Female

Data Collection in Two Parts

1. Usability tests on three graph descriptions that we wrote.

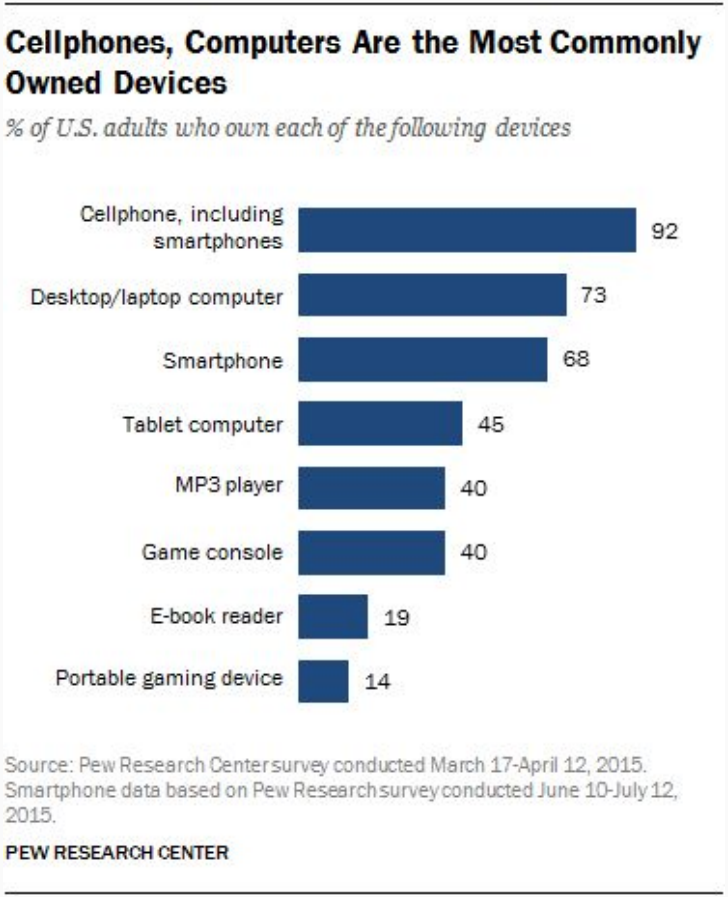
2. Interviews about their experiences with graphs.

Usability tests

Three Levels of Detail:

Simple	+ Graph Overview
Medium	+ Graph Overview + Values per category
Thorough	+ Graph Overview + Values per category + Trends associated with the graph

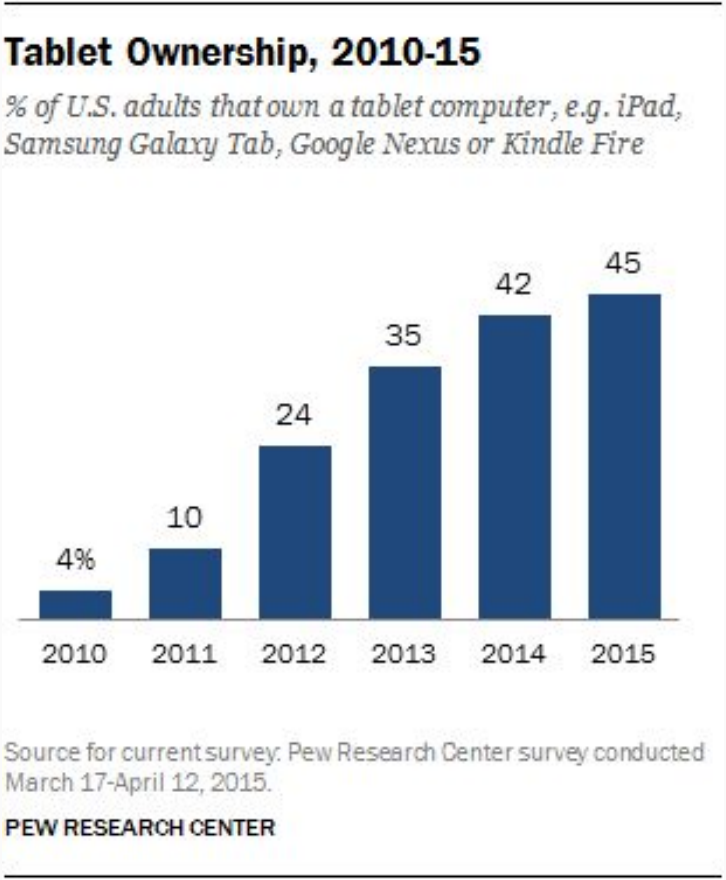
Graph One



Description One

This graph shows the percentage of US adults who own certain devices based on a survey conducted from March 17th to April 12th of 2015. The graph shows that most commonly used devices are cellphones and the least commonly used devices are portable gaming devices.

Graph Two

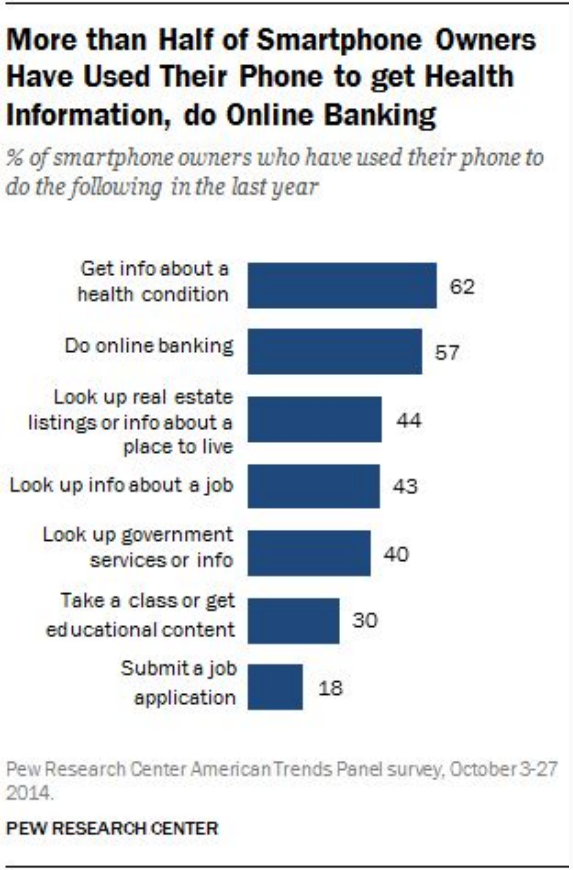


Description Two

This graph shows the percentage of US adults who own a tablet computer, such as an iPad, Samsung Galaxy Tab, Google Nexus, or Kindle Fire from 2010 to 2015. The graph shows that the highest percentage of US adults owning one of these devices occurred in 2015 while the lowest percentage of US adults owning one of these devices occurred in 2010.

- In 2010, 4% of Americans owned a tablet computer
- In 2011, 10% of Americans owned a tablet computer
- In 2012, 24% of Americans owned a tablet computer
- In 2013, 35% of Americans owned a tablet computer
- In 2014, 42% of Americans owned a tablet computer
- In 2015, 45% of Americans owned a tablet computer

Graph Three



Description Three

This graph shows the percentage of smartphone owners who have used their phone to do various tasks in October 2014.

The graph shows that the highest percentage of smartphone users used their phone to get info about a health condition while the lowest percentage of users used their phone to submit a job application.
The graph shows that the order of tasks involving the highest percentage of smartphone users to lowest percentage of smartphone users was as follows: getting info about a health condition, doing online banking, looking up real estate listings or info about a place to live, looking up info about a job, looking up government services or info, taking a class or get educational content, and submitting a job application.

- 62% of smartphone owners used their phone to get info about a health condition.
- 57% of smartphone owners used their phone to do online banking
- 44 of of smartphone owners used their phone to look up real estate listings of info about a place to live
- 43% of smartphone owners used their phone to look up info about a job
- 40% of smartphone owners used their phone to look up government services or info
- 30% of smartphone owners used their phone to take a class or get educational content
- 18% of smartphone owners used their phone to submit a job application

Graph Questions

1. Are you able to describe the overall characteristics of the data? If yes: what are the overall characteristics?

2. Are you able to identify the greatest value? If yes, which has the greatest value?

3. Are you able to identify the smallest value? If yes, which is the smallest?

4. Are you able to identify which two items are the closest values? If so, which two items have the closest values?

Satisfaction Questions

Likert Scale

1. Overall, I found this description easy to understand.
2. I felt as though I could use this description to further my knowledge of an accompanying article.
3. After hearing the description, I felt I had an overall understanding of the graph.

1	2	3	4	5
strongly disagree		neither agree nor disagree		strongly agree

Open-Ended

4. What information do you feel was missing?
5. Was anything included that was not helpful?

Wrap-Up Questions

Thinking about all three graph descriptions…..

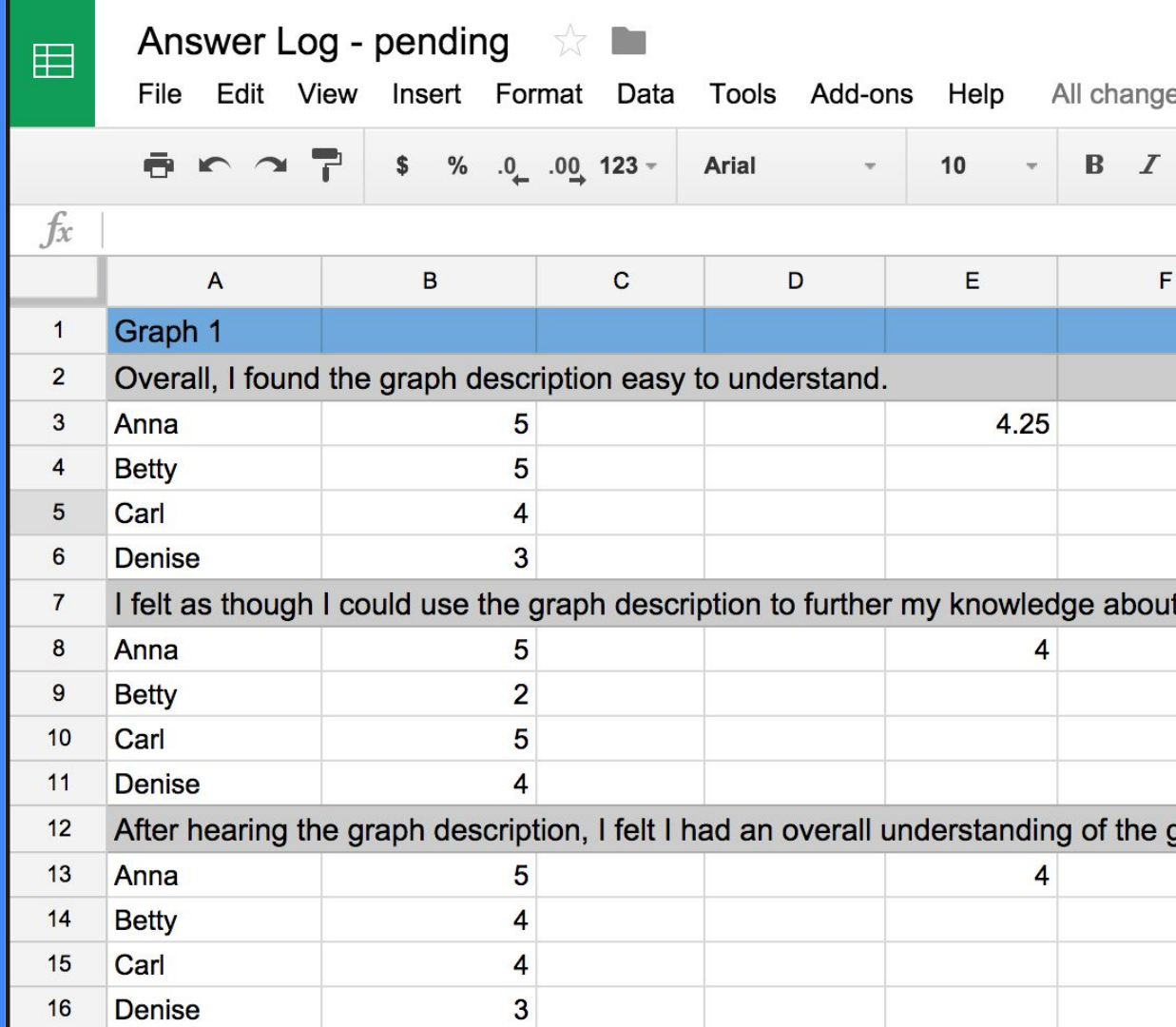
1. What are your thoughts?
2. What did you find most challenging when listening to the graph descriptions?
3. What is the most important information for you in a graph description?
4. Do you have any feedback on the interview or procedure for our future research?
5. Do you have any further questions or comments?

Data Analysis

Transcribed all interviews

Tallied the correct answers to each assessment

Average clarity rating



Answer Log - pending

File Edit View Insert Format Data Tools Add-ons Help All change

$ % .0 .00 123 Arial 10 B I

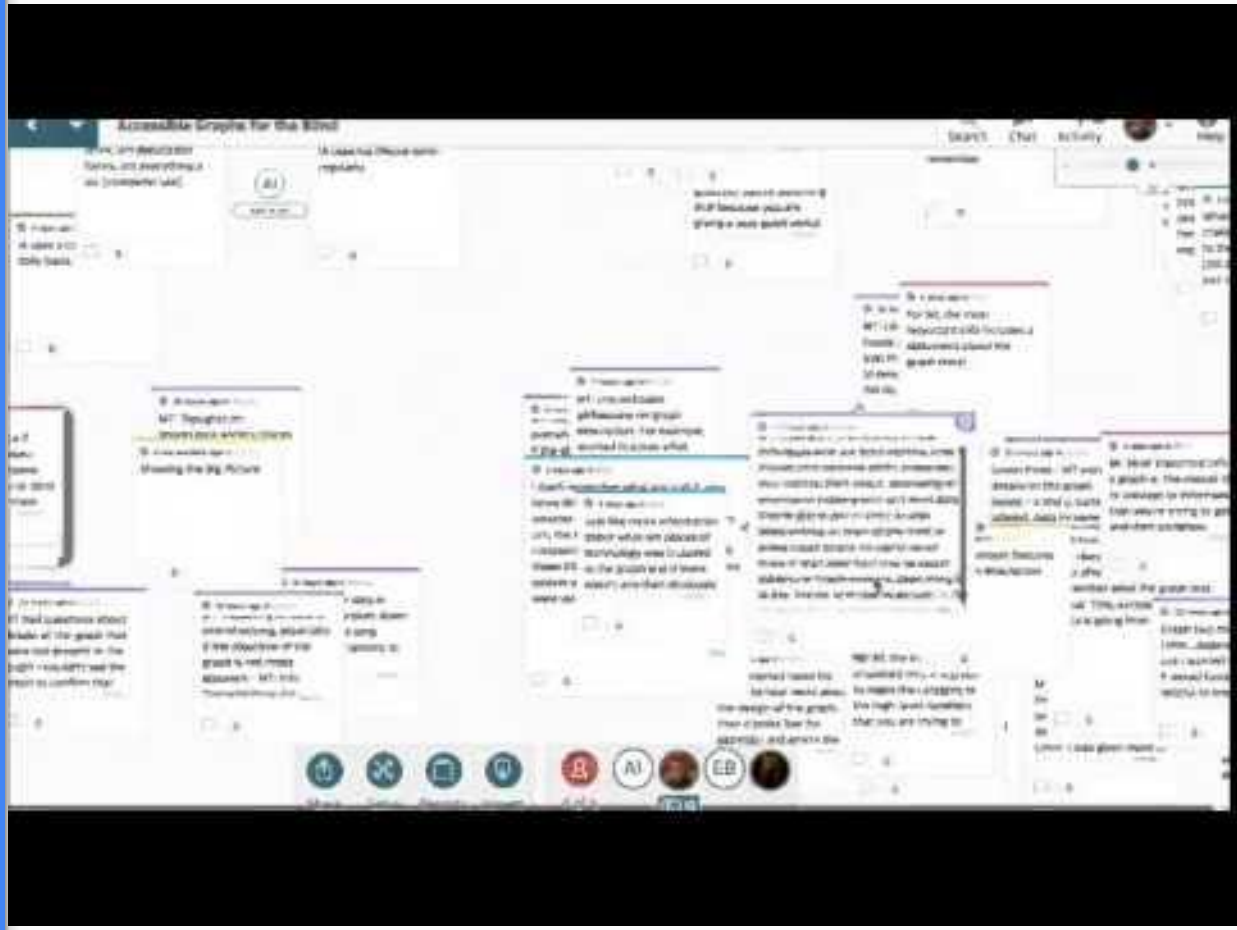
fx

	A	B	C	D	E	F
1	Graph 1					
2	Overall, I found the graph description easy to understand.					
3	Anna	5			4.25	
4	Betty	5				
5	Carl	4				
6	Denise	3				
7	I felt as though I could use the graph description to further my knowledge about					
8	Anna	5			4	
9	Betty	2				
10	Carl	5				
11	Denise	4				
12	After hearing the graph description, I felt I had an overall understanding of the g					
13	Anna	5			4	
14	Betty	4				
15	Carl	4				
16	Denise	3				

Affinity Diagram

Extracted Quotes

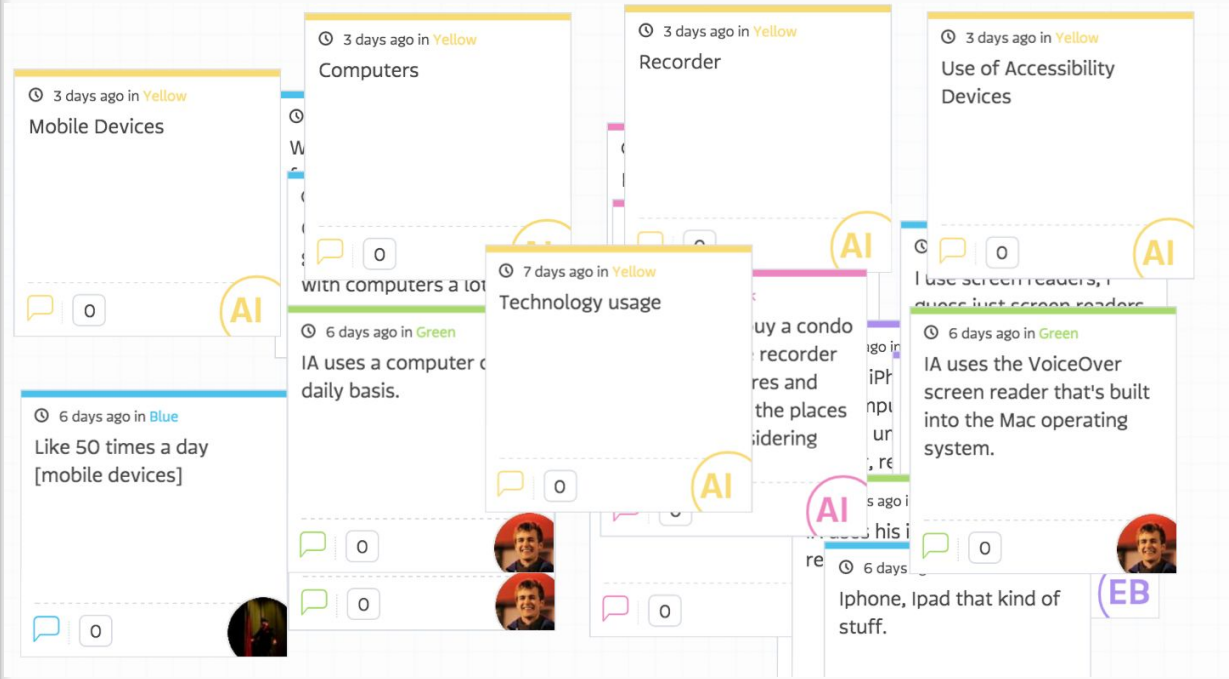
Found Common Themes



FINDINGS

Technology Use

- Mobile Phones, Computers, Screen Readers, Mobile Voice-overs
- Phones for social media, email, calling people, web browsing and checking calendars
- Computers for email, social media, application forms and accessing news



3 days ago in Yellow

Mobile Devices

0

AI

3 days ago in Yellow

Computers

0

AI

3 days ago in Yellow

Recorder

AI

3 days ago in Yellow

Use of Accessibility Devices

0

AI

7 days ago in Yellow

Technology usage

0

AI

6 days ago in Green

IA uses a computer
daily basis.

0

0

6 days ago in Blue

Like 50 times a day [mobile devices]

0

6 days ago in Green

IA uses the VoiceOver screen reader that's built into the Mac operating system.

0

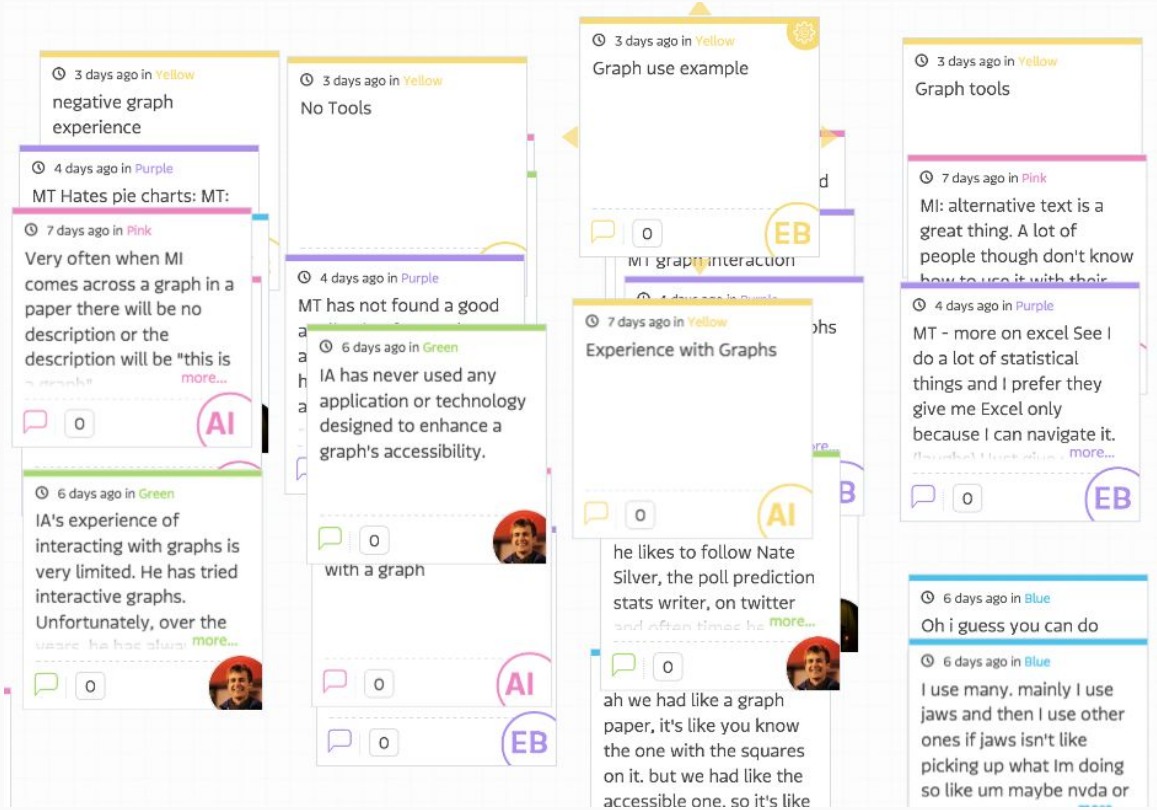
6 days

Iphone, Ipad that kind of stuff.

EB

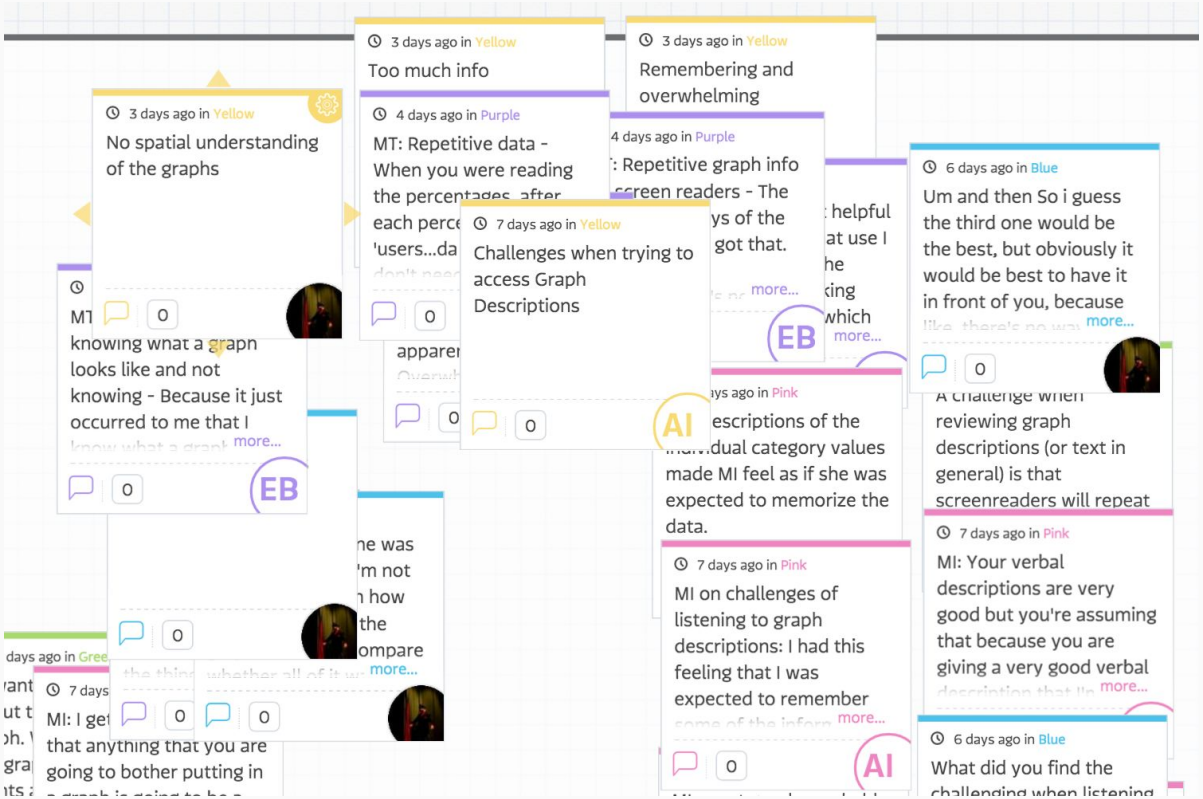
Experience with Graphs

- Paper and digital mediums
- Various settings: School, Work, Hobbies
- Some have used Excel as a tool
- Limited or Nonexistent Screen Reader Support



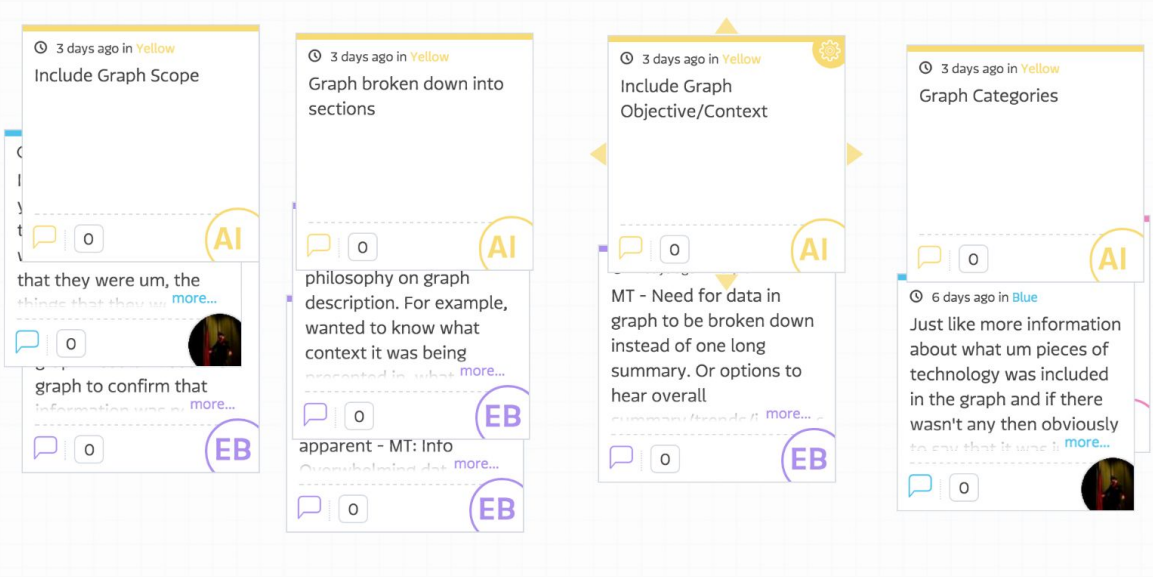
Challenges When Trying to Access Graphs

- Lack of spatial understanding
- The burden of trying to remember a lot of information
- The challenge of sorting through repetitive data



Most Important Features in a Graph Description

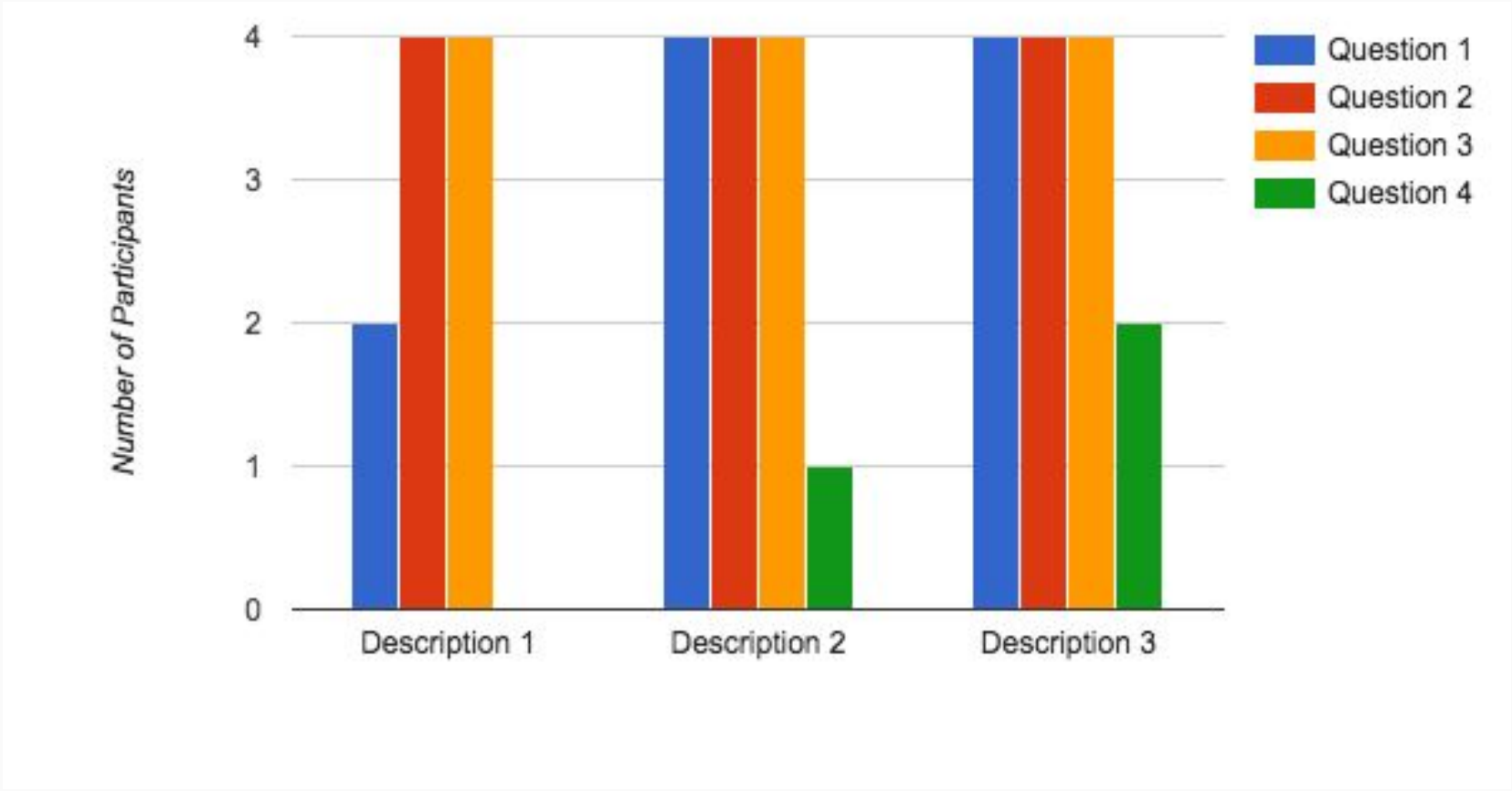
- Type of graph
- Graph scope
- Objective or context of the graph
- Sections of distributed content, categories, values, and trends.



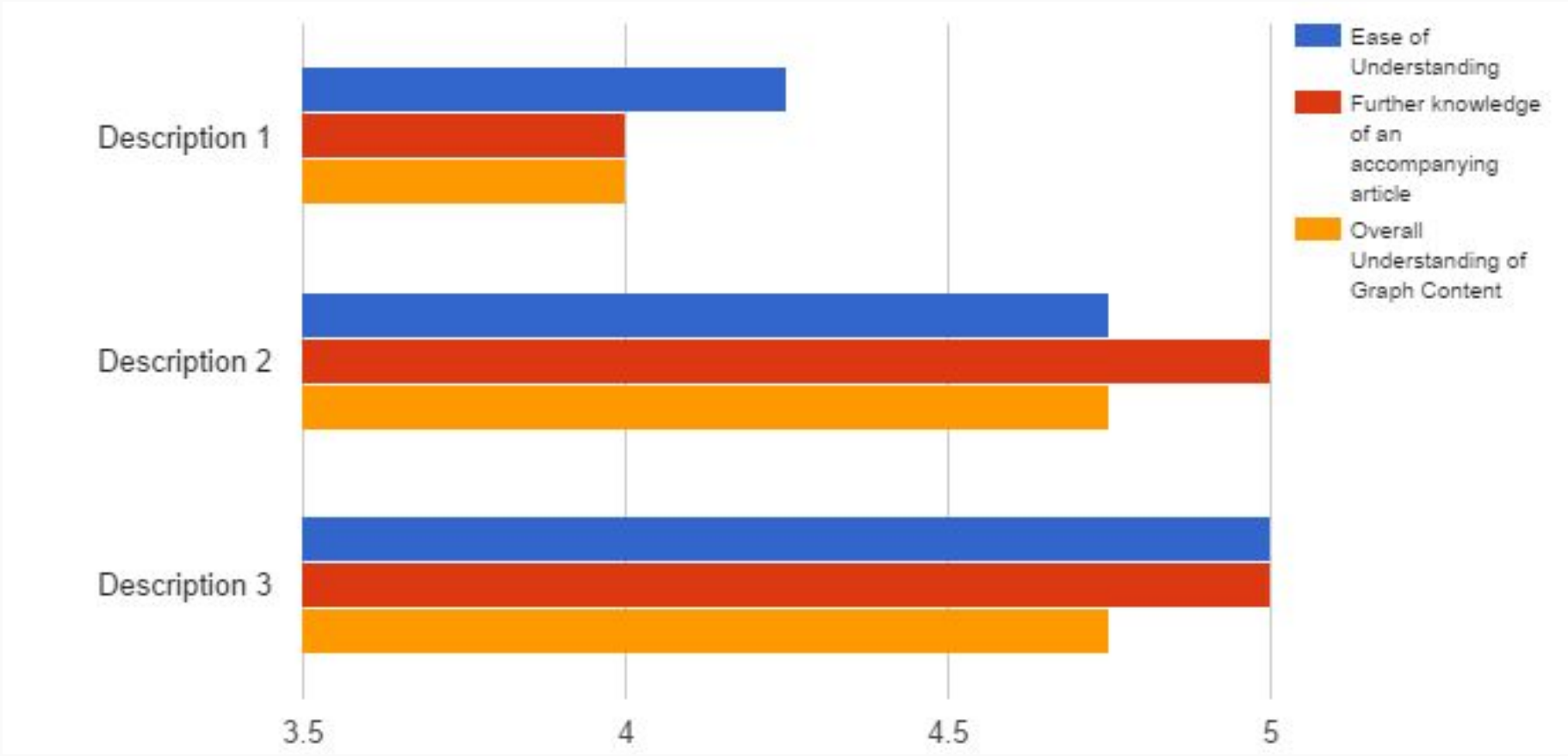
Just tell me the conclusions, and if you say there's a chart here that'll give you more detail but it's not going to be integral to what I want to know, which is the trend.

Denise

Understanding Graph Content through Graph Descriptions



Graph Descriptions - Clarity, Ease of Use



DISCUSSION

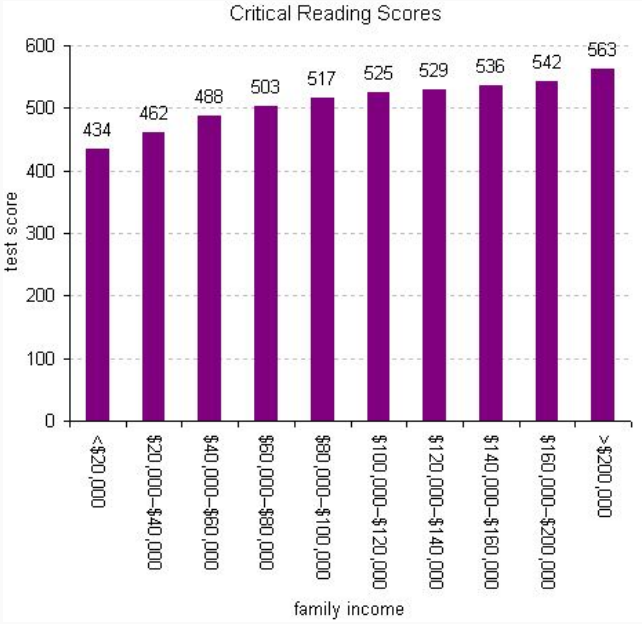
Graph Description Guidelines

State the Context

Make context clear in the description

How is the author using the graph?

State purpose and context



<table>
<caption>This graph, which appeared in a New York Times article entitled ‘SAT Scores and Family Income,’ supports the article’s claim that there is a strong correlation between a higher family income and higher SAT scores.
</caption>
</table>

Provide access to the graph’s data on demand

Scoping

```
<table>

<caption>...</caption>

<tr>
<th scope="col">ID</th>
<th scope="col">Measurement</th>
<th scope="col">Average</th>
<th scope="col">Maximum</th>
</tr>

<tr>
<td>10</td>
<th scope="row">Tails</th>
<td>1</td>
<td>1</td>
</tr>

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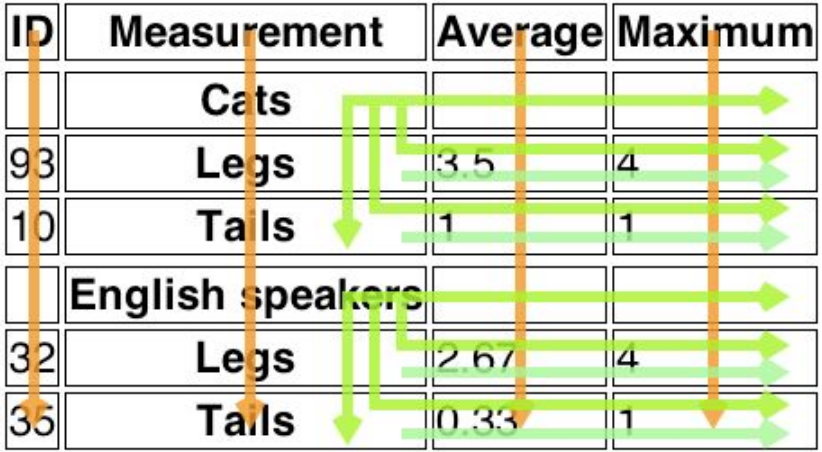
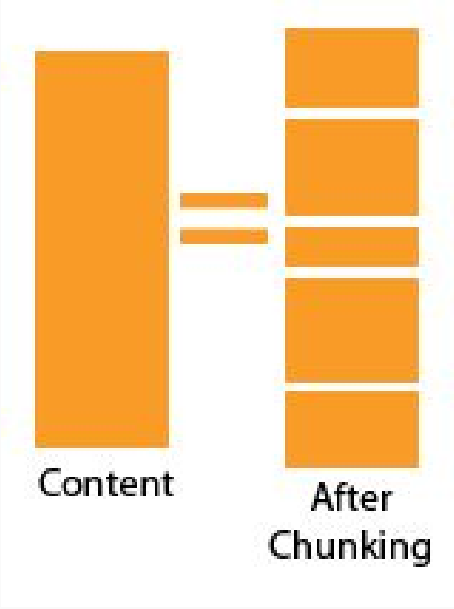


Minimize Cognitive Load

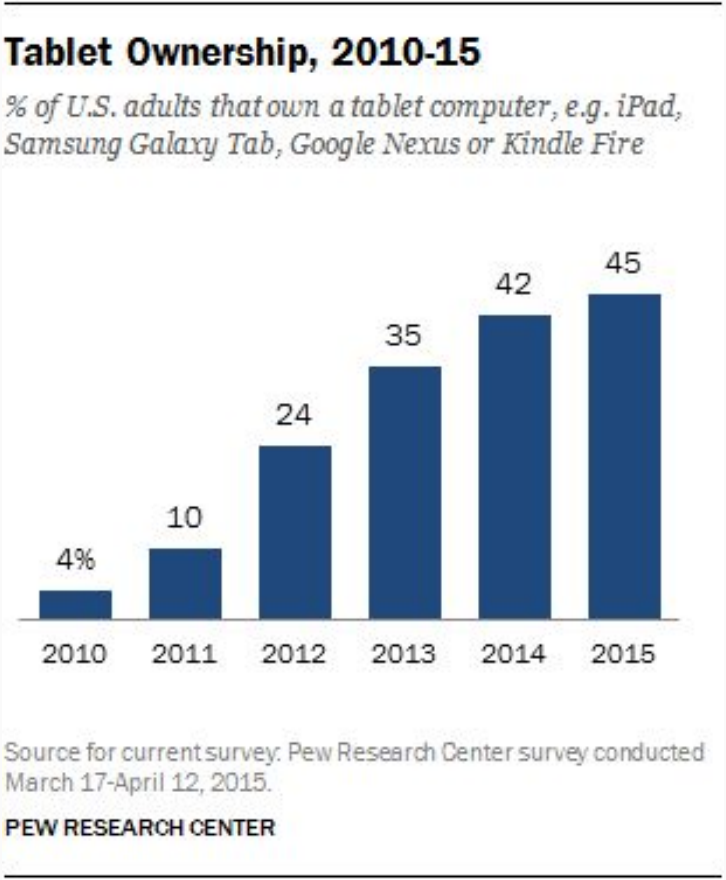
Information chunking

Clear declarative writing

Remove repetitive descriptions



Graph Two



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- In 2010, 4% of Americans owned a tablet computer
- In 2011, 10%
- In 2012, 24%
- In 2013, 35%
- In 2014, 42%
- In 2015, 45%

Limitations and Next Steps

- Limitations
  - The small sample size limits generalization
  - Graph’s lack of context for the study participants
- Next Steps
  - Test the guidelines we outlined above
  - Test conditions where participants interact with a graph that accompanies an article
  - Larger sample size

Study Postmortem

- Patronizing questions
- Did we ask the right questions? — “What information is missing?”
- Denis’s comments about “nothing about us without us”

You don't think like I do. I know it, trust me! And it's much easier if we can have a conversation like this because then you're not going to go farther along creating this app or this other thing that I can't use...Okay you did a lot of work, alright, alright, alright. But you're not helping me. So why didn't you check with me right away? It's the whole '**Nothing about us without us**' *kind of thing. So as long as we're in the mix, we'll talk to you.*

Denise

Thank You

Questions?