

Building User Interfaces

Designing for

Accessibility

Professor Bilge Mutlu

What we will learn today?

- What is accessibility?
- Accessible design
- Assistive technologies

What is accessibility?

Definitions

Usability: The effectiveness, efficiency, and satisfaction with which a specified set of users can achieve a specified set of tasks in a particular environment. — ISO 9241-11

Accessibility: The usability of a product, service, environment, or facility by people with the widest range of capabilities. — ISO 9241-20

From Accessibility to Disability

Accessibility is the extent to which an interactive product is accessible by as many people as possible.

The primary focus of accessible design is making systems accessible to individuals with *disabilities*.

Disability¹

Definition: A *disability* is any condition of the body or mind (impairment) that makes it more difficult for the person with the condition to do certain activities (activity limitation) and interact with the world around them (participation restrictions).

Disability can change over time with age or recovery, and the severity of the impact of disability can change over time. Fewer than 20% are born with a disability, although 80% of people will have a disability once they reach 85.

¹ CDC

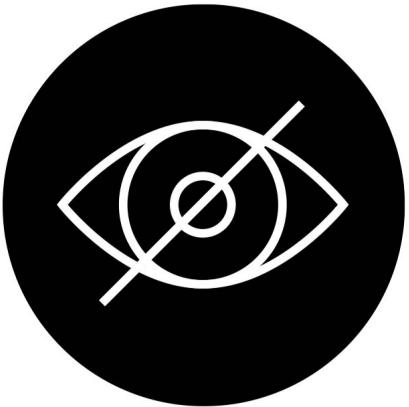
Three Dimensions of Disability²

1. **Impairment** in a person's body structure or function, or mental functioning (e.g., loss of a limb, loss of vision, or memory loss)
2. **Limitation in activities** (e.g., difficulty seeing, hearing, walking, or problem solving)
3. **Restrictions in participation** in activities of daily living (e.g., working, engaging in social and recreational activities, and obtaining health care)

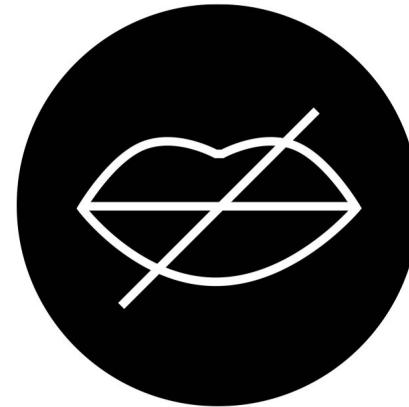
²Source: World Health Organization

Types of Impairment: Anatomical³

1. Sensory impairment
2. Physical impairment
3. Cognitive impairment



Can't see



Can't speak



Can't hear



Can't touch

³ Image source: [Microsoft Inclusive Design Toolkit](#)

Sensory Impairment

Involves impairment in one or more senses, such as loss of vision or hearing.

Physical Impairment

Involves loss of function to one or more parts of the body, e.g., congenitally or after stroke or spinal-cord injury.

Cognitive Impairment

Includes cognitive deficits, such as learning impairment or loss of memory/cognitive function due to aging or conditions such as Alzheimer's disease.

Common Impairments

- Visual
- Motor/Mobility
- Auditory
- Seizures
- Learning

Visual Disabilities

Definition: Impairments in vision, including long-sightedness, blindness, and color blindness.

Motor/Mobility

Definition: Muscular or skeletal impairments in the hands or arms that affect user input as well as impairments that affect mobility, where users are in a wheelchair or bedridden, and thus the context of use.

Auditory

Definition: Deficits that affect hearing at different levels of severity, including deafness.

Seizures

Definition: Neurological impairments, such as photosensitive epilepsy, that result in sensitivity to light, motion, and flickering on screen, which might trigger seizures.

Cognitive/Learning

Definition: Congenital, developmental, and traumatic (e.g., traumatic brain injury) conditions that result in cognitive or learning challenges.

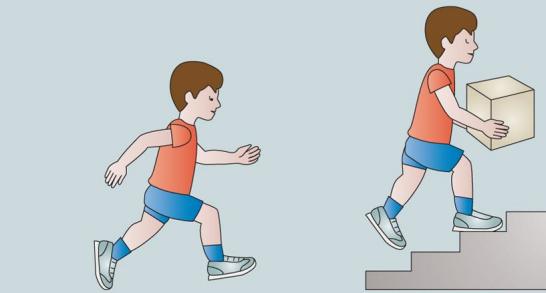
Variability⁴

Impairments can vary in severity or structure depending on the source and nature of the impairment.

Severity: Children with cerebral palsy can have basic mobility or completely depend on a caretaker.

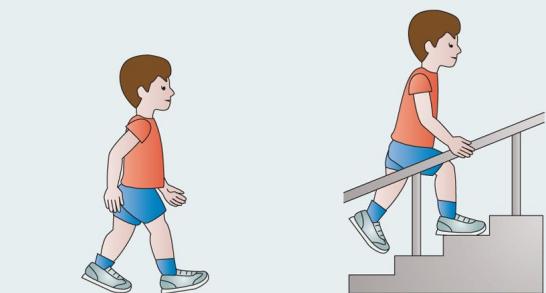
Structure: Vision impairments can include color blindness, peripheral-only vision, no light perception

GMFCS expanded and revised between 6th and 12th birthday: descriptors and illustrations



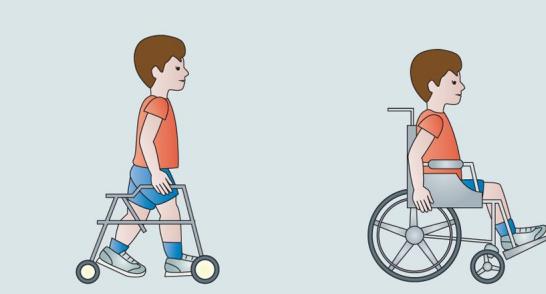
GMFCS level I

Children walk at home, school, outdoors and in the community. They can climb stairs without the use of a railing. Children perform gross motor skills such as running and jumping, but speed, balance and coordination are limited.



GMFCS level II

Children walk in most settings and climb stairs holding onto a railing. They may experience difficulty walking long distances and balancing on uneven terrain, inclines, in crowded areas or confined spaces. Children may walk with physical assistance, a hand-held mobility device or use wheeled mobility over long distances. Children have only minimal ability to perform gross motor skills such as running and jumping.



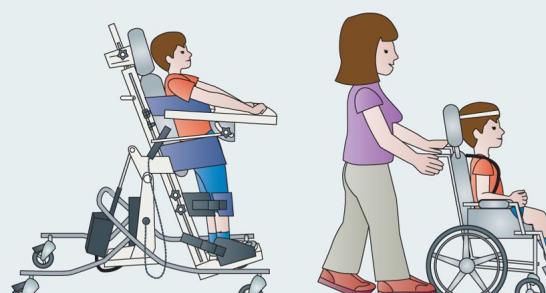
GMFCS level III

Children walk using a hand-held mobility device in most indoor settings. They may climb stairs holding onto a railing with supervision or assistance. Children use wheeled mobility when travelling long distances and may self-propel for shorter distances.



GMFCS level IV

Children use methods of mobility that require physical assistance or powered mobility in most settings. They may walk for short distances at home with physical assistance or use powered mobility or a body support walker when positioned. At school, outdoors and in the community children are transported in a manual wheelchair or use powered mobility.



GMFCS level V

Children are transported in a manual wheelchair in all settings. Children are limited in their ability to maintain antigravity head and trunk postures and control leg and arm movements.

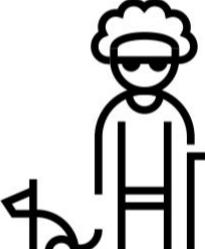
⁴[Image source](#)

Types of Impairment: Temporal

1. *Permanent* impairment
2. *Temporary* impairment
3. *Situational* impairment

Permanent Impairment⁵

Congenital or long-term conditions, such as color blindness, missing body parts, etc.

	Permanent	Temporary	Situational
Touch			
One arm	Arm injury	New parent	
See			
Blind	Cataract	Distracted driver	
Hear			
Deaf	Ear infection	Bartender	
Speak			
Non-verbal	Laryngitis	Heavy accent	

⁵ Image source: [Microsoft Inclusive Design Toolkit](#)

Temporary Impairment⁶

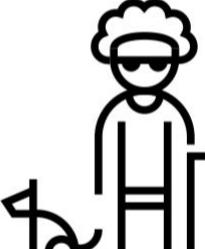
Impairments that improve over time, such as recovery after illness or accidents, e.g., a broken arm.

	Permanent	Temporary	Situational
Touch			
	One arm	Arm injury	New parent
See			
	Blind	Cataract	Distracted driver
Hear			
	Deaf	Ear infection	Bartender
Speak			
	Non-verbal	Laryngitis	Heavy accent

⁶ Image source: [Microsoft Inclusive Design Toolkit](#)

Situational Impairment⁷

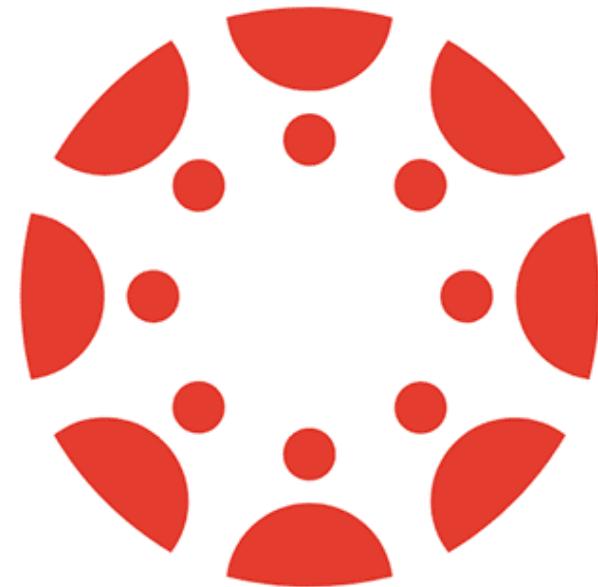
Impairments introduced by context, such as environments with low light or noise.

	Permanent	Temporary	Situational
Touch			
	One arm	Arm injury	New parent
See			
	Blind	Cataract	Distracted driver
Hear			
	Deaf	Ear infection	Bartender
Speak			
	Non-verbal	Laryngitis	Heavy accent

⁷Image source: [Microsoft Inclusive Design Toolkit](#)

Quiz 1

Complete the Canvas quiz.



canvas

How do we achieve accessibility?

Two ways to address accessibility problems:

1. Accessible design
2. Assistive technologies

Accessible Design

Context-dependent Model of Disability

Disability as personal attribute

In the context of health experience, a disability is any restriction or lack of ability (resulting from an impairment) to perform an activity in the manner or within the range considered normal for a human being.

Disability as context dependent

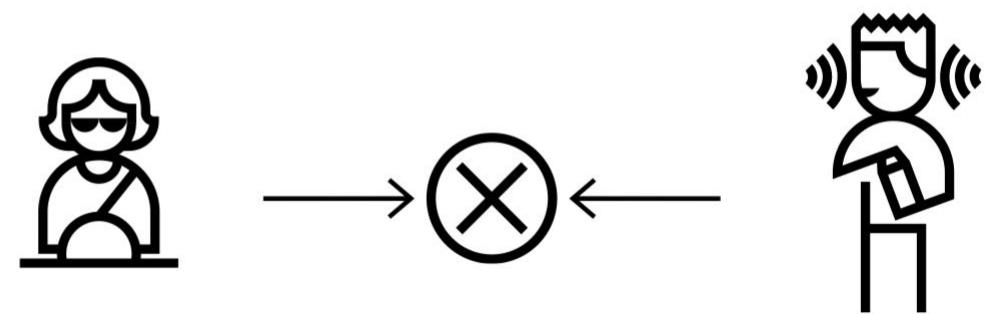
Disability is not just a health problem. It is a complex phenomenon, reflecting the interaction between features of a person's body and features of the society in which he or she lives.

Mismatch between Abilities and Environment⁸

Context-dependent disability results from a mismatch between abilities and the environment:

$$\text{Ability} + \text{Context} = \text{Disability}$$

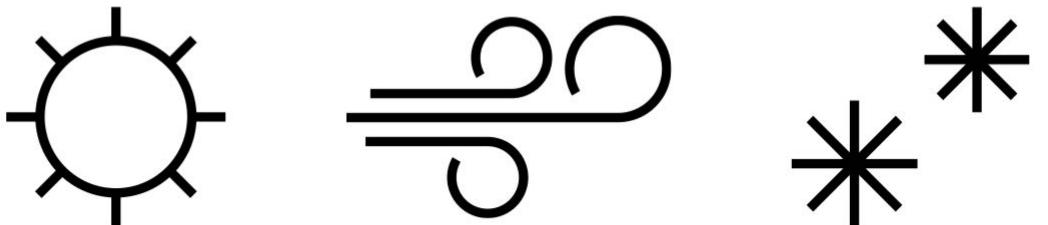
Between humans



Can't type

Can't hear

Human+ environment

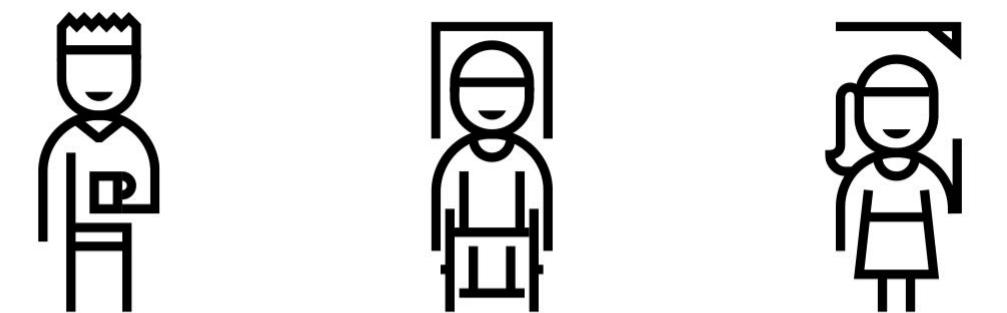


Glare from sun

Windy

Cold

Human+ object



Left-handed user

Narrow door

Tall shelf

⁸ Image source: [Microsoft Inclusive Design Toolkit](#)

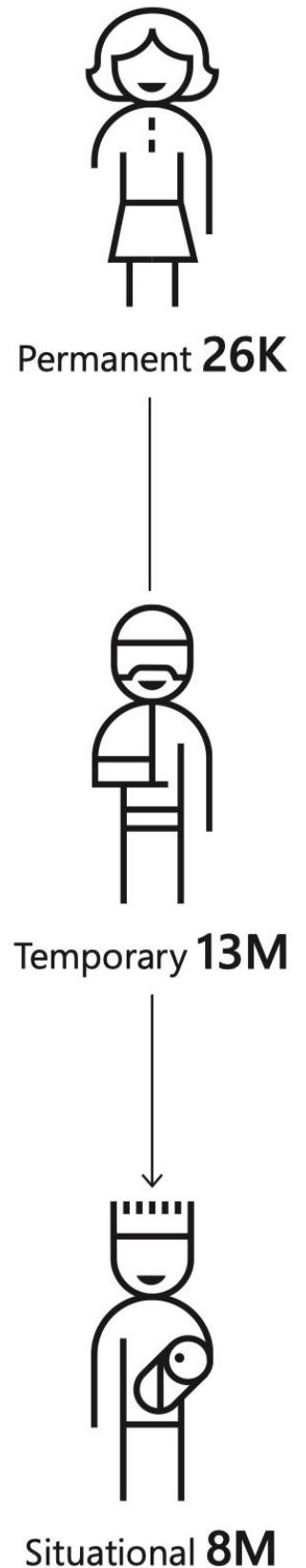
Universal Design⁹

Definition: The design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design.

⁹ Ron Mace, 1996

The Main Premise of Universal Design¹⁰

Design solutions that benefit some individuals may benefit the whole society. E.g., in the US, only 26K people are suffer loss of upper extremities. Designs that would benefit these 26K would also benefit another 21M people with temporary or situational disabilities.



¹⁰ Image source: [Microsoft Inclusive Design Toolkit](#)

An Example: Closed Captioning¹¹

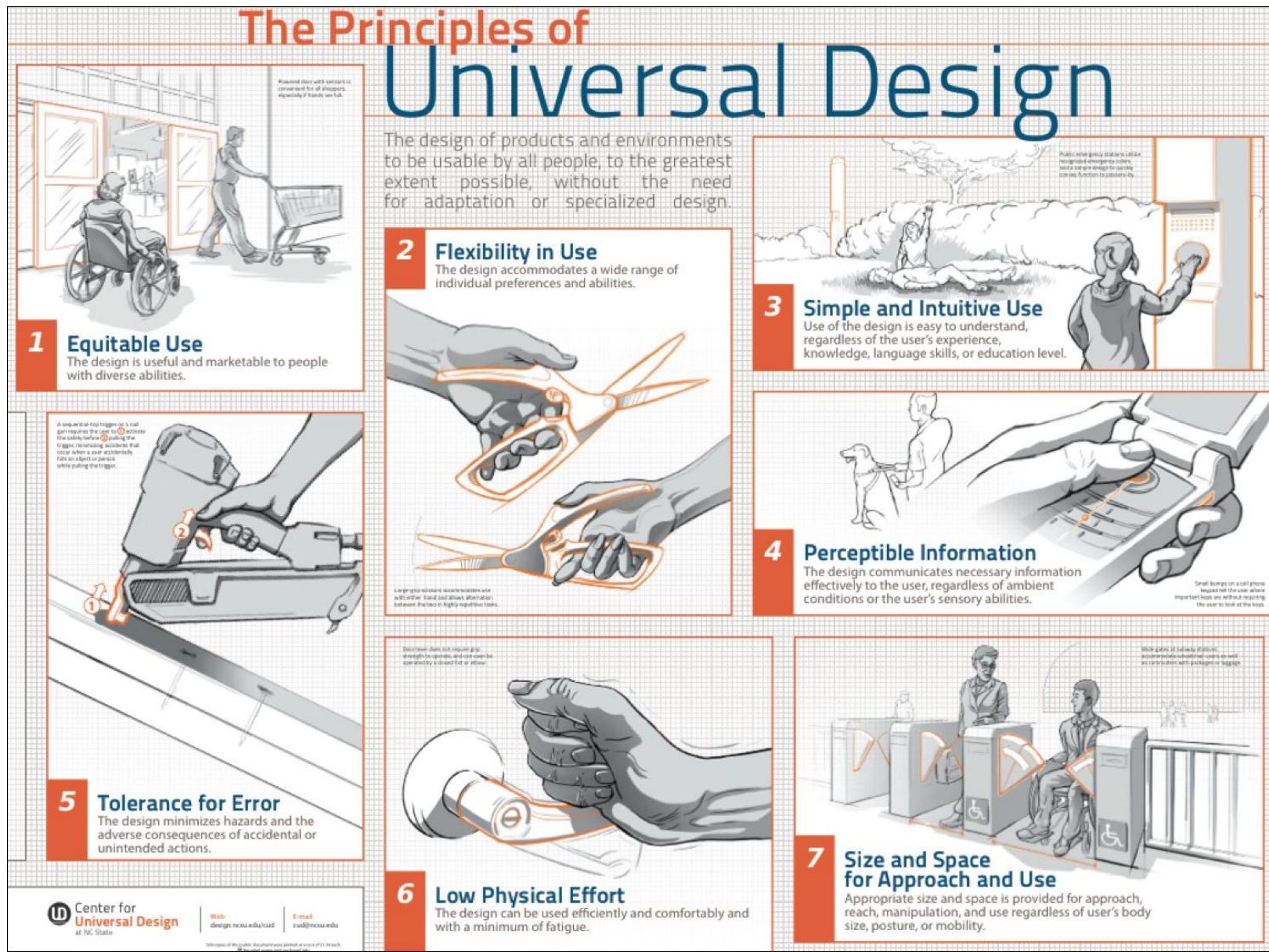
Although closed captioning was originally developed for individuals with hearing impairments, they now also benefit reading in noisy environments and learning to read.



¹¹ Image source: [Microsoft Inclusive Design Toolkit](#)

Principles of Universal Design

1. Equitable use
2. Flexibility in use
3. Simple and intuitive use
4. Perceptible information
5. Tolerance for error
6. Low physical effort
7. Size and space for approach and use

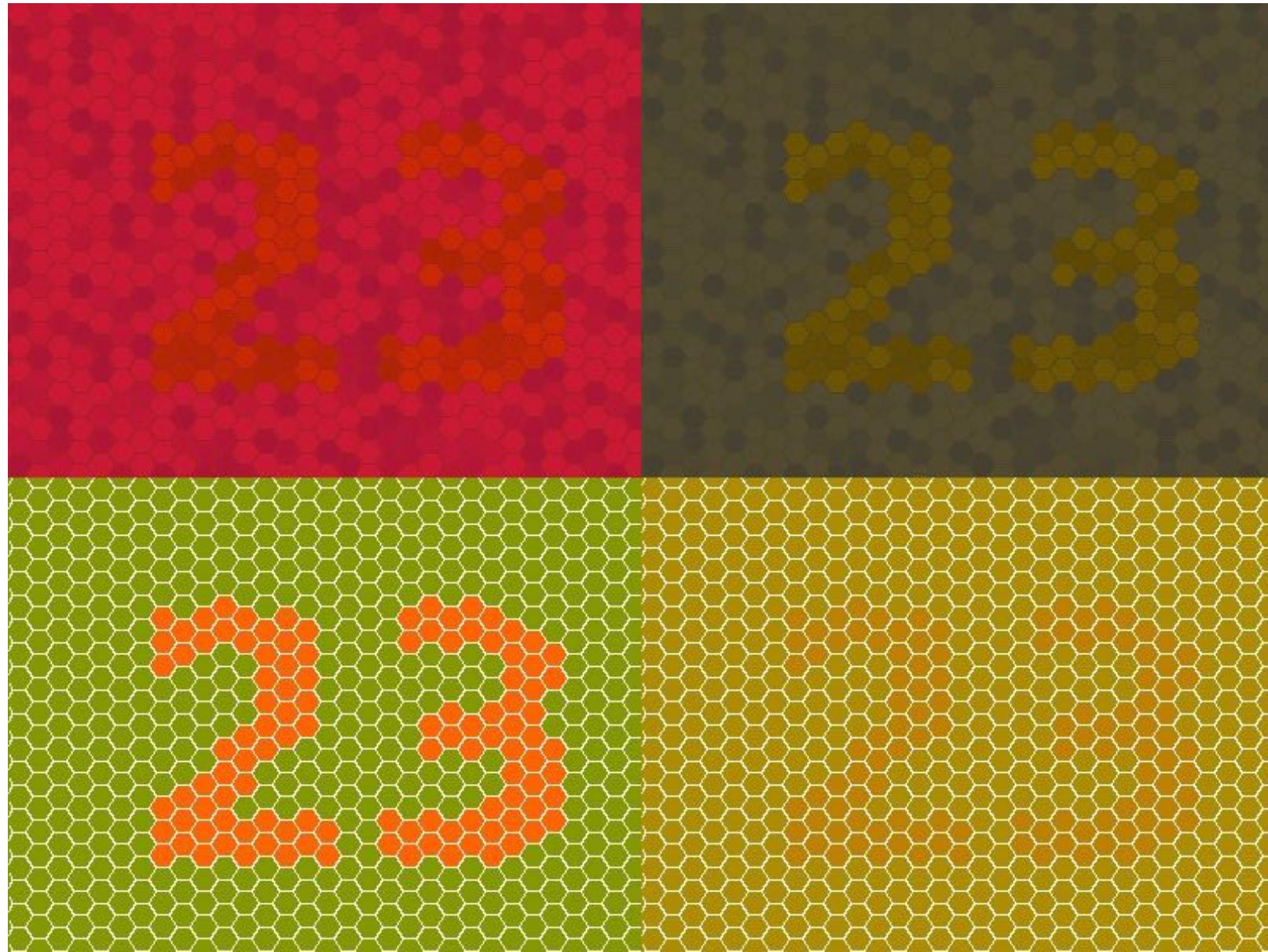


¹² Image source: [Interaction Design Foundation](#)

Principle 1: Equitable use

The design is useful and marketable to people with diverse abilities.

1. Provide the same means of use for all users: identical whenever possible; equivalent when not.
2. Avoid segregating or stigmatizing any users.
3. Provisions for privacy, security, and safety should be equally available to all users.
4. Make the design appealing to all users.

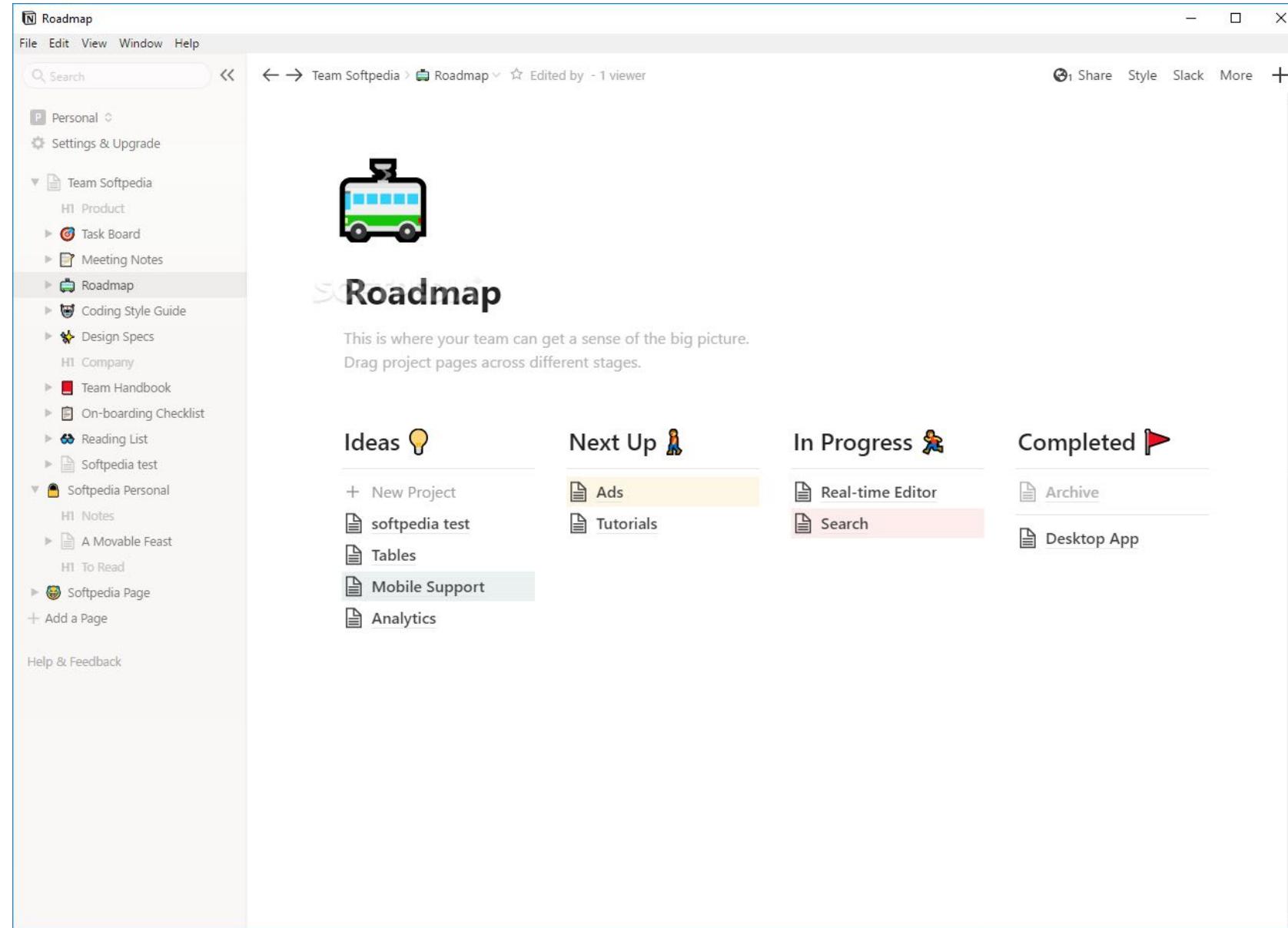


¹³ Example source: [Interaction Design Foundation](#); Image source: Johannes Ahlmann

Principle 2: Flexibility in Use

The design accommodates a wide range of individual preferences and abilities.

1. Provide choice in methods of use.
2. Accommodate right- or left-handed access and use.
3. Facilitate the user's accuracy and precision.
4. Provide adaptability to the user's pace.

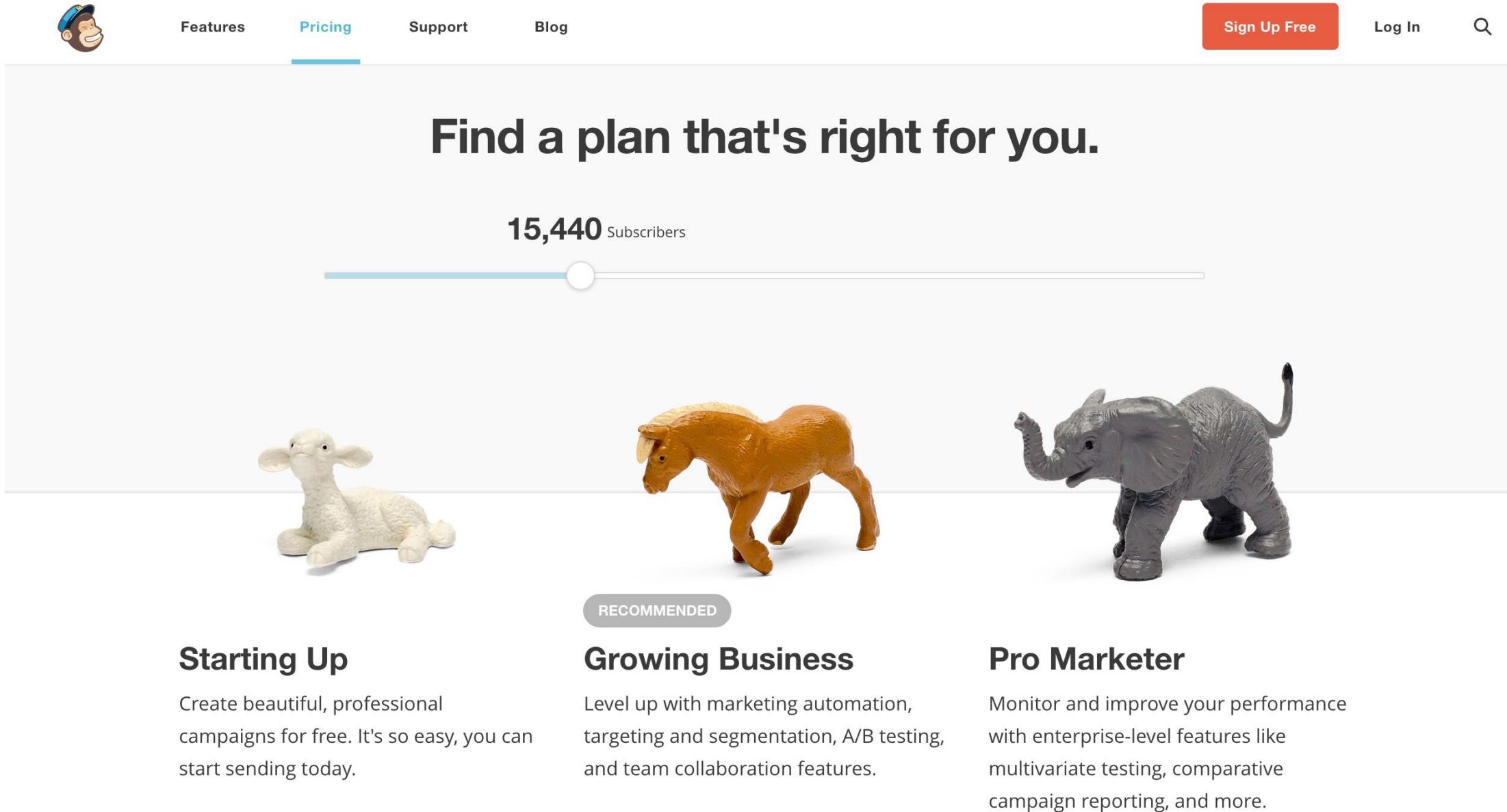


¹⁴ Image source

Principle 3: Simple and Intuitive Use

Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level.

1. Eliminate unnecessary complexity.
2. Be consistent with user expectations and intuition.
3. Accommodate a wide range of literacy and language skills.
4. Arrange information consistent with its importance.
5. Provide effective prompting and feedback during and after task completion.



The screenshot shows the Mailchimp Pricing page. At the top, there is a navigation bar with icons for Features, Pricing (which is highlighted in blue), Support, and Blog. To the right are buttons for Sign Up Free (in red), Log In, and a search icon. The main heading is "Find a plan that's right for you." Below it, a statistic shows "15,440 Subscribers". Three plan options are displayed, each represented by a toy animal: a white lamb for "Starting Up", an orange horse for "Growing Business", and a grey elephant for "Pro Marketer". Each option has a "RECOMMENDED" badge above its description. The descriptions are as follows:

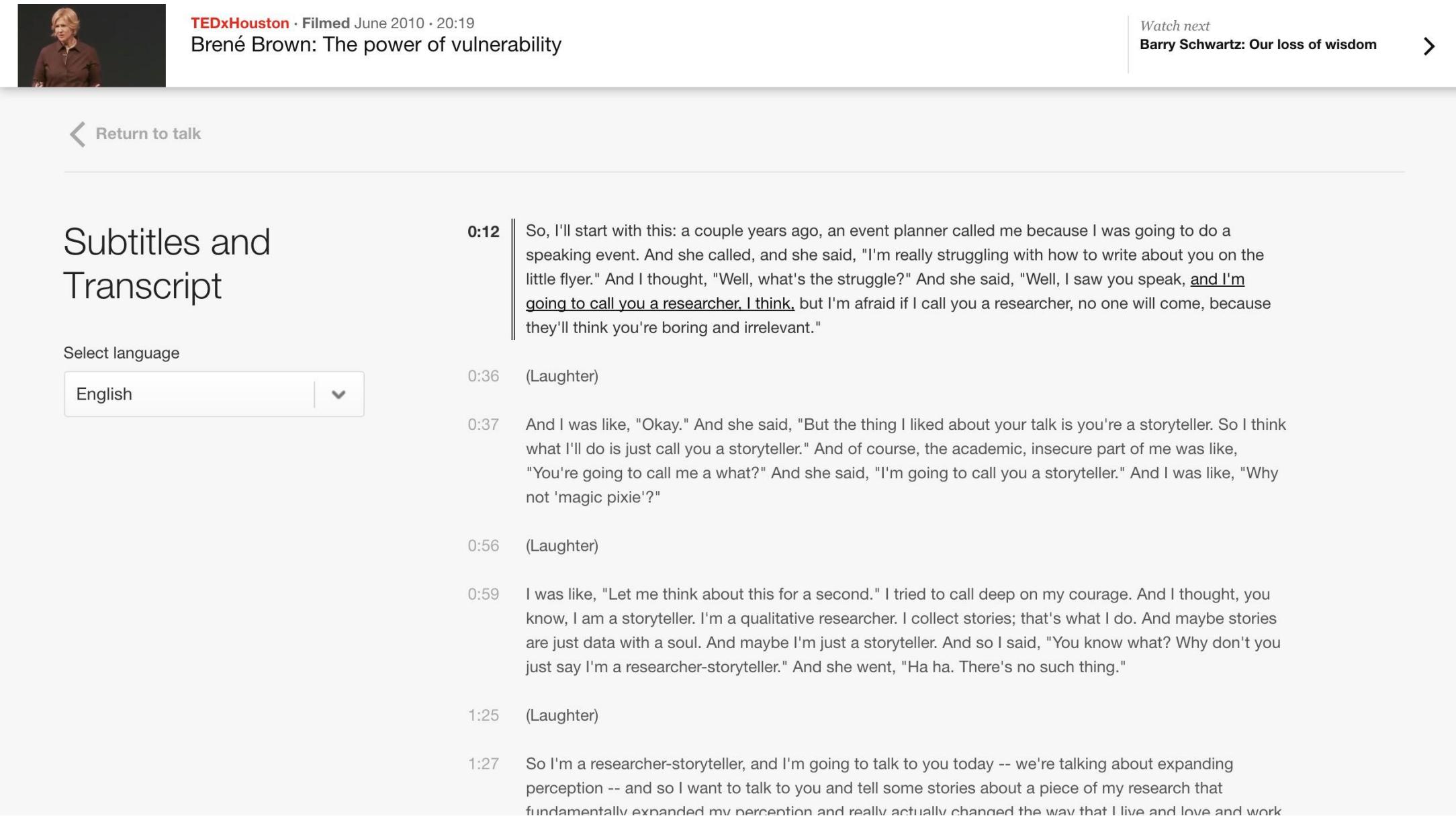
- Starting Up**
Create beautiful, professional campaigns for free. It's so easy, you can start sending today.
- Growing Business**
Level up with marketing automation, targeting and segmentation, A/B testing, and team collaboration features.
- Pro Marketer**
Monitor and improve your performance with enterprise-level features like multivariate testing, comparative campaign reporting, and more.

¹⁵ Example source: [Interaction Design Foundation](#)

Principle 4: Perceptible Information

The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.

1. Use different modes (pictorial, verbal, tactile) for redundant presentation of essential information.
2. Provide adequate contrast between essential information & surroundings.
3. Maximize "legibility" of essential information
4. Differentiate elements in ways that can be described (i.e., make it easy to give instructions or directions).
5. Provide compatibility with a variety of techniques or devices used by people with sensory limitations.



The screenshot shows a TEDx video player interface. At the top, there is a thumbnail of Brené Brown speaking, followed by the text "TEDxHouston · Filmed June 2010 · 20:19" and the title "Brené Brown: The power of vulnerability". To the right, there is a "Watch next" section with a thumbnail for "Barry Schwartz: Our loss of wisdom" and a right-pointing arrow. Below the main video area, there is a "Return to talk" button with a left-pointing arrow. The main content area is titled "Subtitles and Transcript". On the left, there is a "Select language" dropdown menu with "English" selected. The transcript is displayed in a list format with timestamps and corresponding text. Some text in the transcript is underlined, such as "and I'm going to call you a researcher, I think," and "fundamentally expanded my perception and really actually changed the way that I live and love and work".

Subtitles and Transcript

Select language

English

0:12 So, I'll start with this: a couple years ago, an event planner called me because I was going to do a speaking event. And she called, and she said, "I'm really struggling with how to write about you on the little flyer." And I thought, "Well, what's the struggle?" And she said, "Well, I saw you speak, and I'm going to call you a researcher, I think, but I'm afraid if I call you a researcher, no one will come, because they'll think you're boring and irrelevant."

0:36 (Laughter)

0:37 And I was like, "Okay." And she said, "But the thing I liked about your talk is you're a storyteller. So I think what I'll do is just call you a storyteller." And of course, the academic, insecure part of me was like, "You're going to call me a what?" And she said, "I'm going to call you a storyteller." And I was like, "Why not 'magic pixie'?"

0:56 (Laughter)

0:59 I was like, "Let me think about this for a second." I tried to call deep on my courage. And I thought, you know, I am a storyteller. I'm a qualitative researcher. I collect stories; that's what I do. And maybe stories are just data with a soul. And maybe I'm just a storyteller. And so I said, "You know what? Why don't you just say I'm a researcher-storyteller." And she went, "Ha ha. There's no such thing."

1:25 (Laughter)

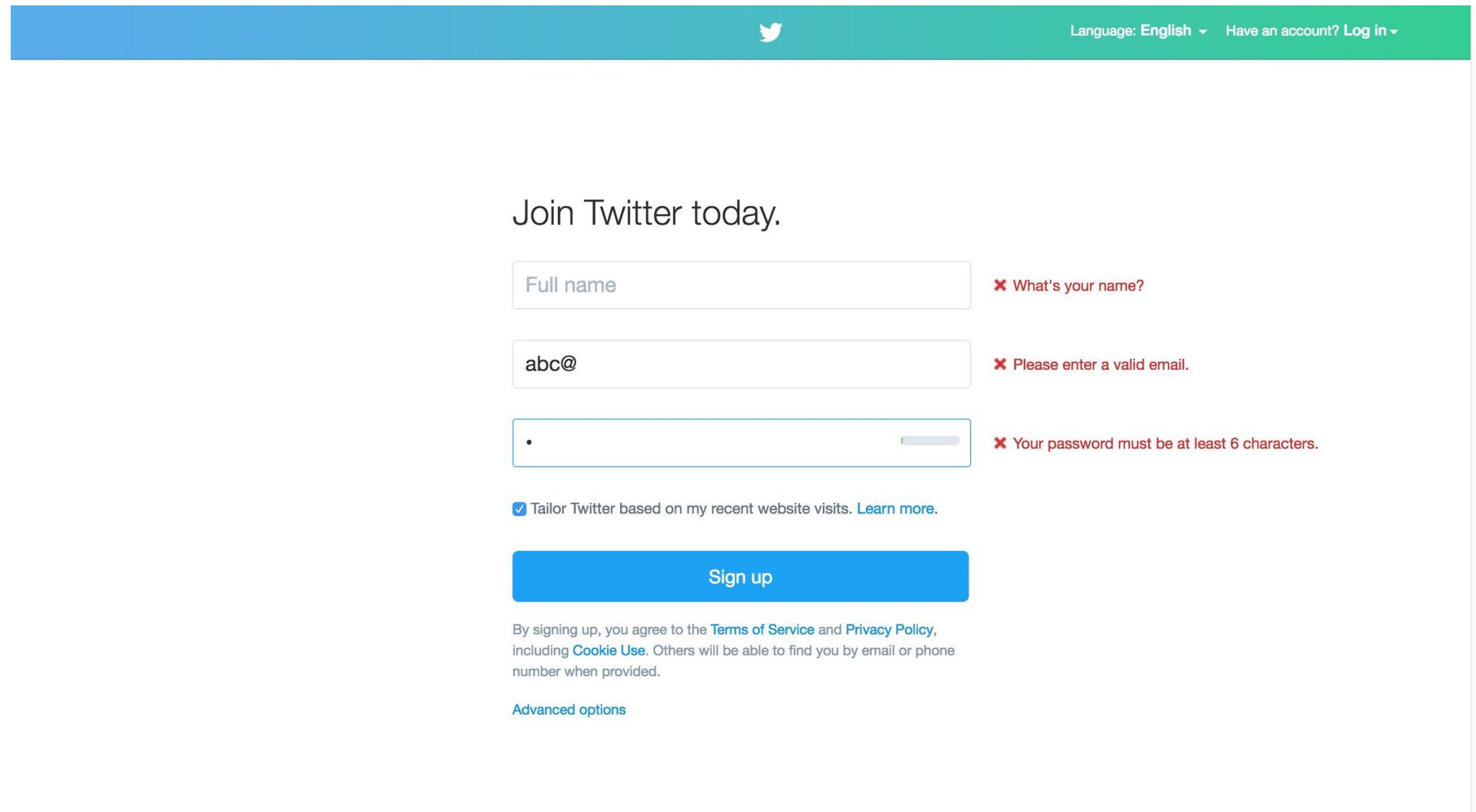
1:27 So I'm a researcher-storyteller, and I'm going to talk to you today -- we're talking about expanding perception -- and so I want to talk to you and tell some stories about a piece of my research that fundamentally expanded my perception and really actually changed the way that I live and love and work

¹⁶ Image source: [Interaction Design Foundation](#)

Principle 5: Tolerance for Error

The design minimizes hazards and the adverse consequences of accidental or unintended actions.

1. Arrange elements to minimize hazards and errors: most used elements, most accessible; hazardous elements eliminated, isolated, or shielded.
2. Provide warnings of hazards and errors.
3. Provide fail safe features.
4. Discourage unconscious action in tasks that require vigilance.



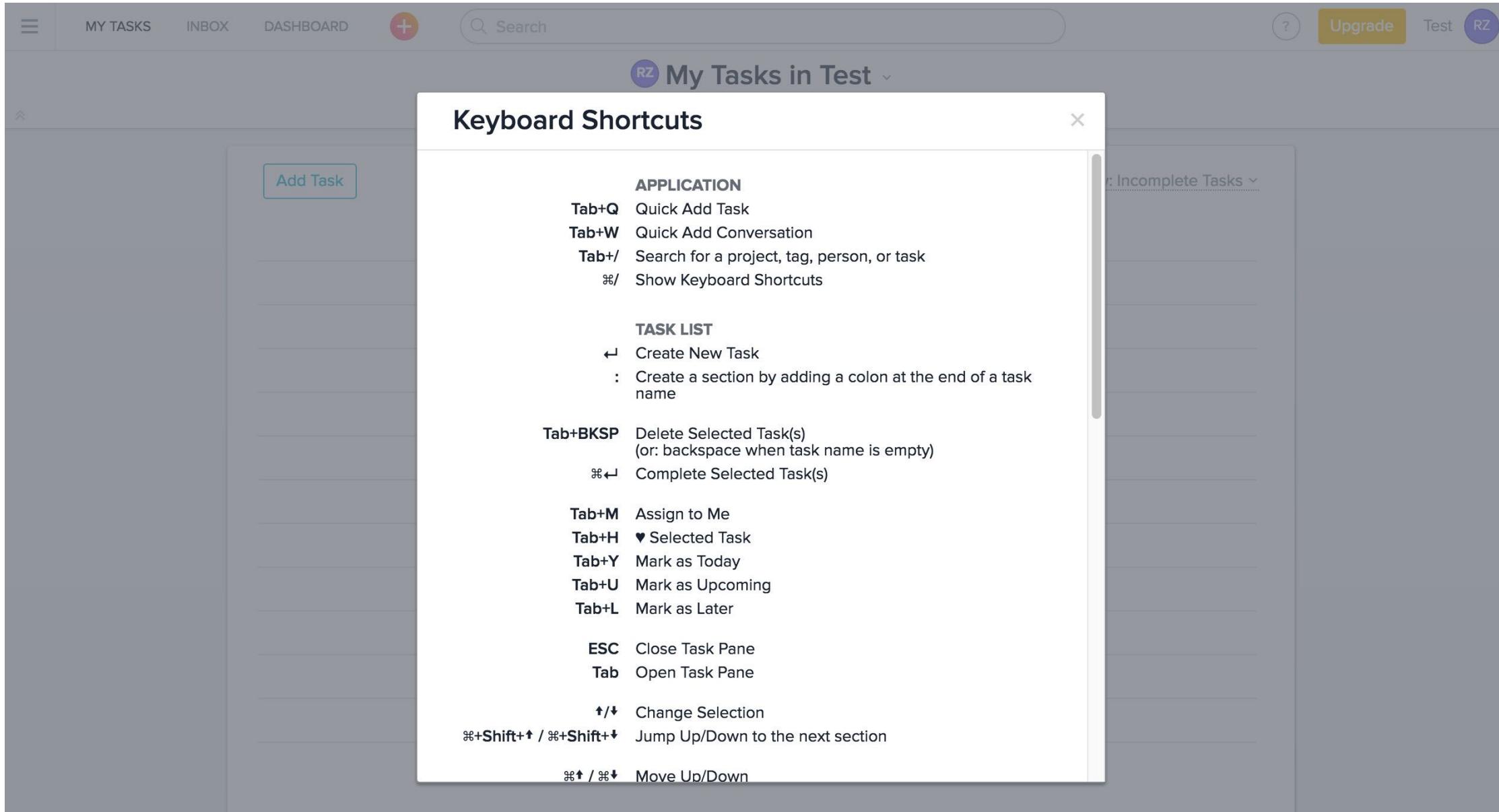
The image shows the Twitter sign-up page. At the top, there is a blue header bar with the Twitter logo and language settings ('Language: English'). Below the header, the main heading is 'Join Twitter today.' There are three input fields: 'Full name' (containing 'John Doe'), 'Email address' (containing 'abc@'), and 'Password' (containing '123456'). Each field has a red error message to its right: 'What's your name?', 'Please enter a valid email.', and 'Your password must be at least 6 characters.' Below the fields is a checkbox for 'Tailor Twitter based on my recent website visits' with the link 'Learn more.' A large blue 'Sign up' button is centered at the bottom. Below the button, a small note states: 'By signing up, you agree to the [Terms of Service](#) and [Privacy Policy](#), including [Cookie Use](#). Others will be able to find you by email or phone number when provided.' There is also a link to 'Advanced options'.

¹⁷ Image source: [Interaction Design Foundation](#)

Principle 6: Low Physical Effort

The design can be used efficiently and comfortably and with a minimum of fatigue.

1. Allow user to maintain a neutral body position.
2. Use reasonable operating forces.
3. Minimize repetitive actions.
4. Minimize sustained physical effort.



¹⁸ Image source: [Interaction Design Foundation](#)

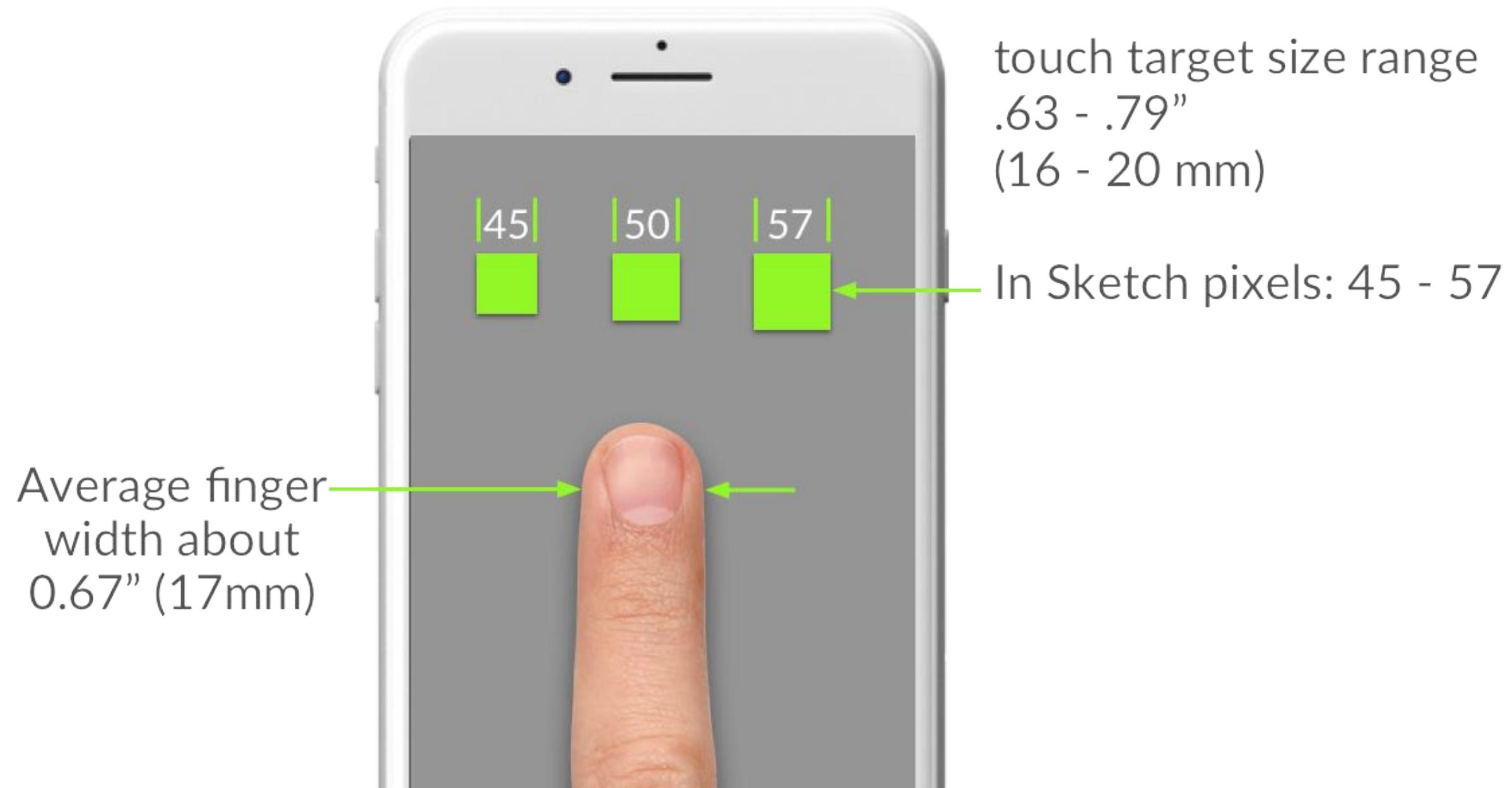
Principle 7: Size and Space for Approach and Use

Appropriate size and space is provided for approach, reach, manipulation, and use regardless of user's body size, posture, or mobility.

1. Provide a clear line of sight to important elements for any seated or standing user.
2. Make reach to all components comfortable for any seated or standing user.
3. Accommodate variations in hand and grip size.
4. Provide adequate space for the use of assistive devices or personal assistance.¹⁹

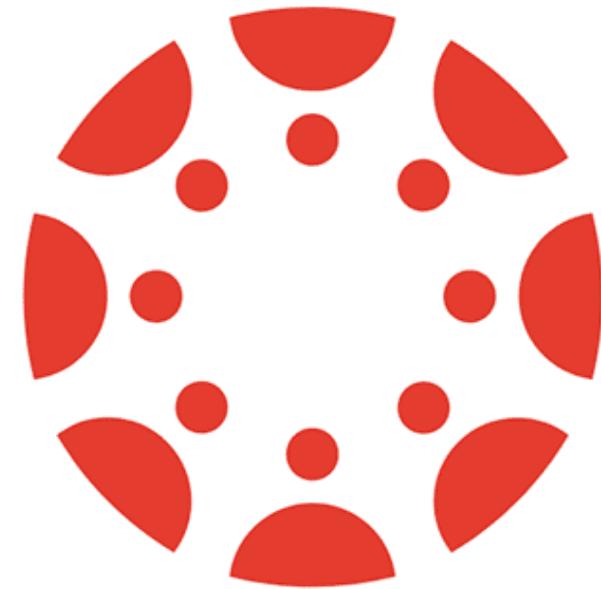
¹⁹ Image source on next slide

iPhone 8
375 x 667 pixel screen size



Quiz 2

Complete the Canvas quiz.



canvas

Assistive Technologies

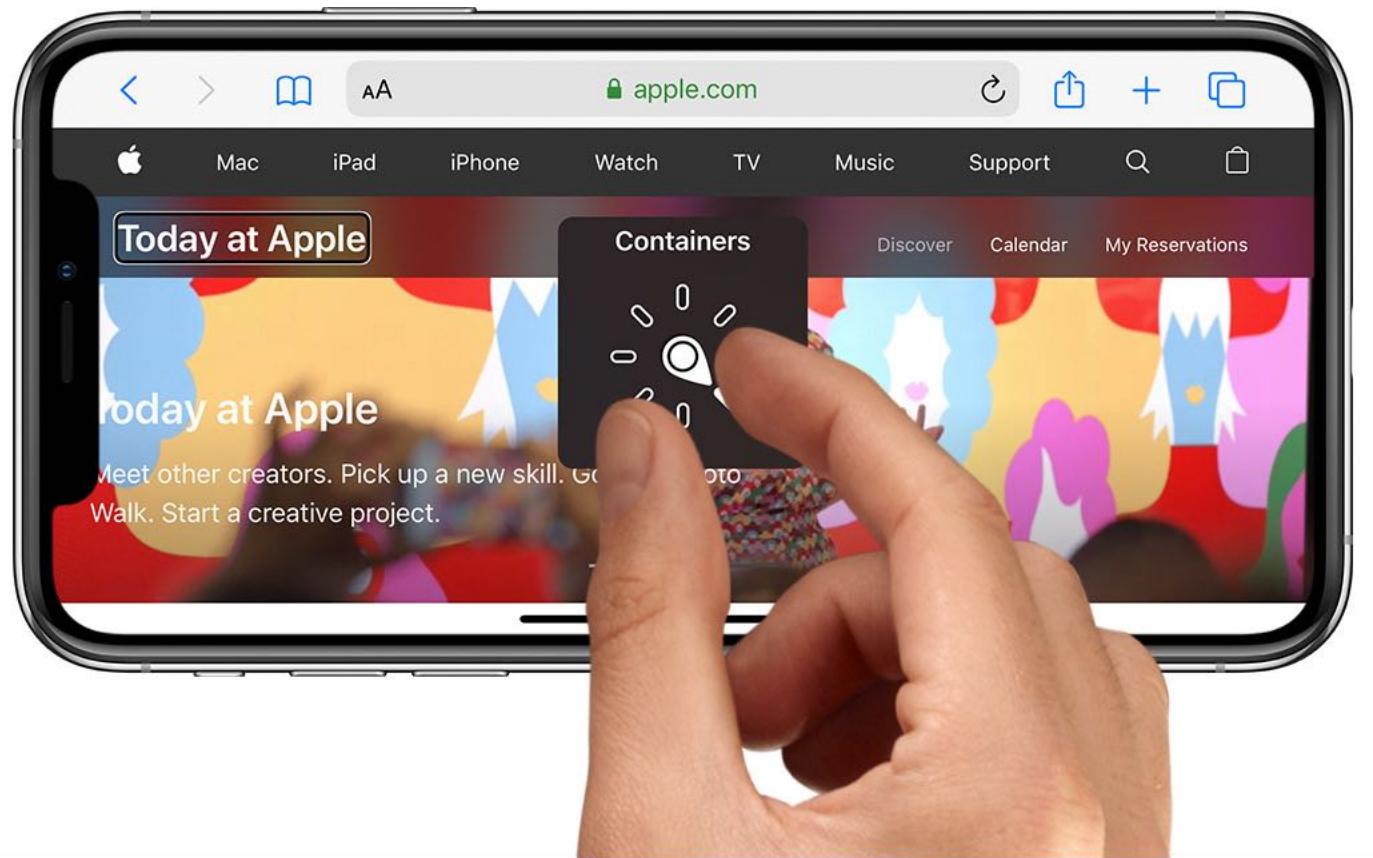
What are assistive technologies?

Definition: Specialized tools that close accessibility gaps.

Screen Readers²⁰

Definition: Software used by individuals with vision impairments to read screen content.

- JAWS for Windows
- VoiceOver for MacOS, iOS
- NVDA



²⁰ [Image source](#)

Screen Magnification²¹

Definition: Enlarges text or graphics on screens to improve visibility of content for individuals with limited vision.



²¹ [Image source](#)

Text Readers²²

Definition: Tools that read out loud text on screens to support vision and learning disabilities.



²² [Image source](#)

Braille for the Web²³

Definition: A mechanical device that translates textual content on the screen into Braille.



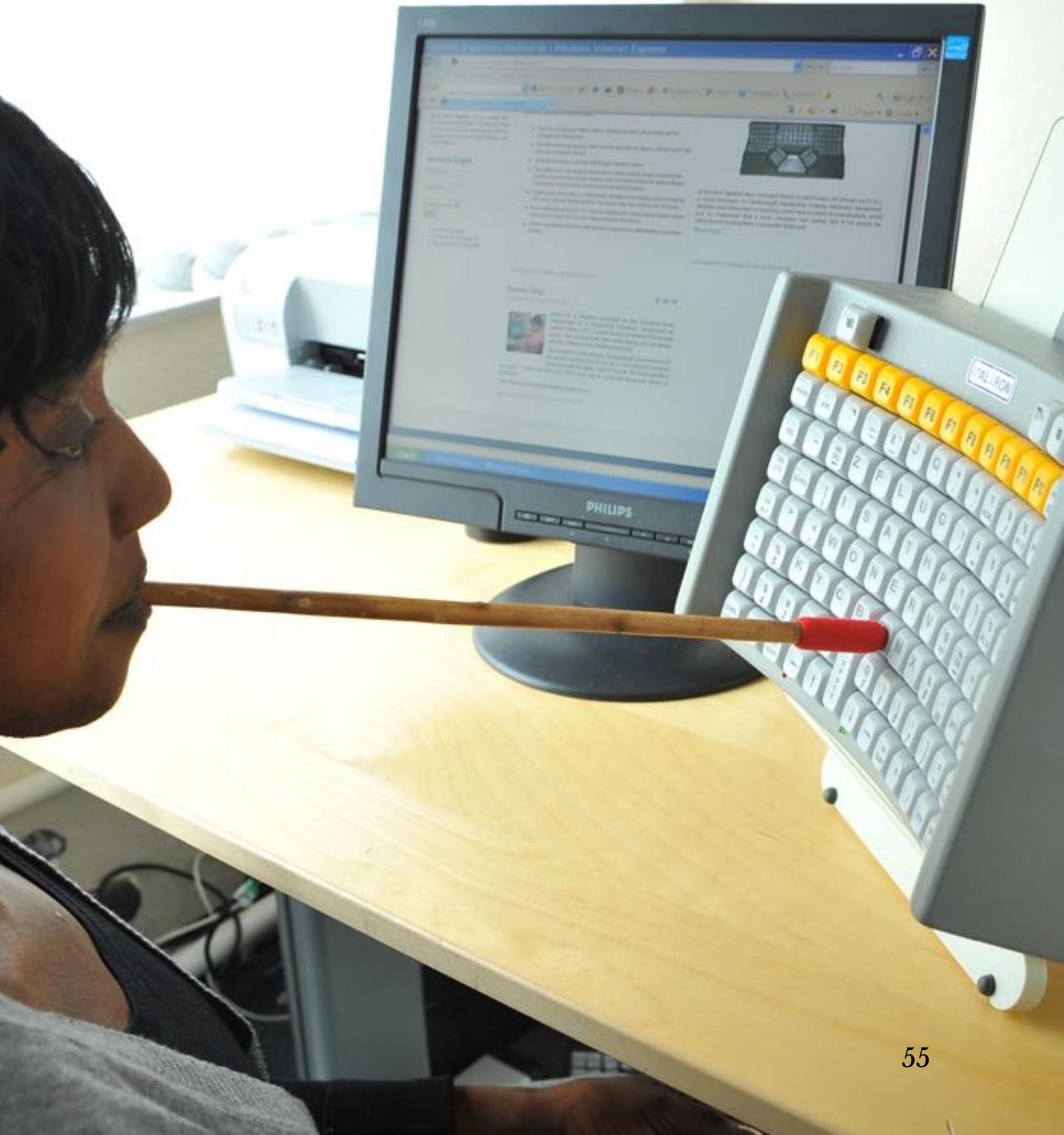
²³ [Image source](#)

Alternative Input Devices

Definition: Specialized tools that help individuals with motor impairments who cannot use a mouse or keyboard with pointing.

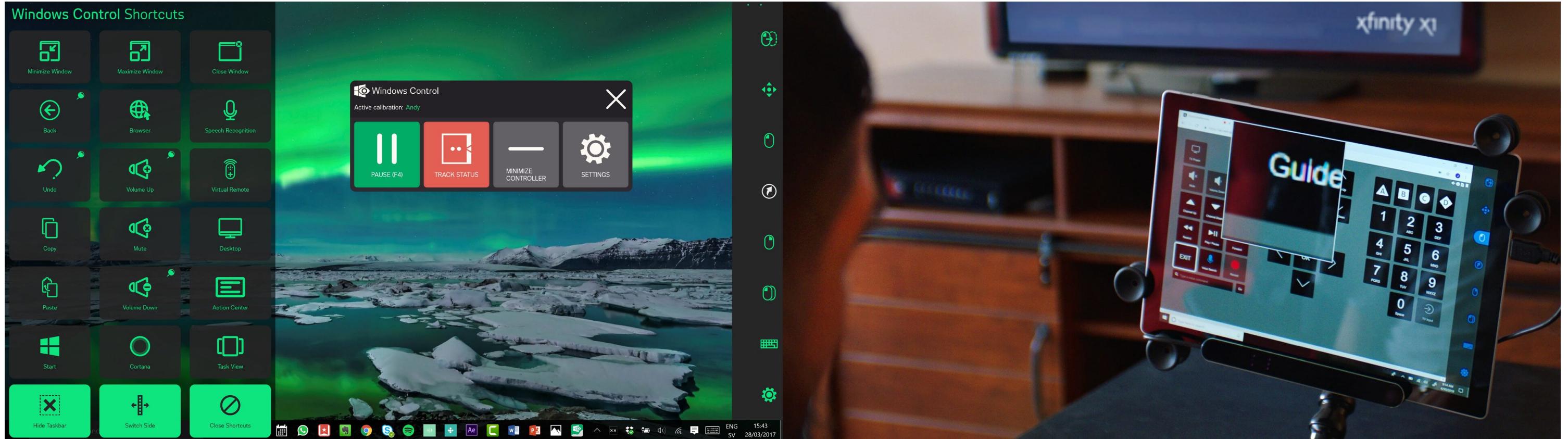
- Head/mouth wands/pointers
- Motion/eye tracking
- Single-switch (e.g., sip-and-puff)
- Speech input

Head/mouth wands/pointers²⁴



²⁴ [Image source](#)

Motion/eye tracking²⁵



²⁵ Image source: [left](#), [right](#)

Single-switch (e.g., sip-and-puff)²⁶



²⁶ [Image source](#)

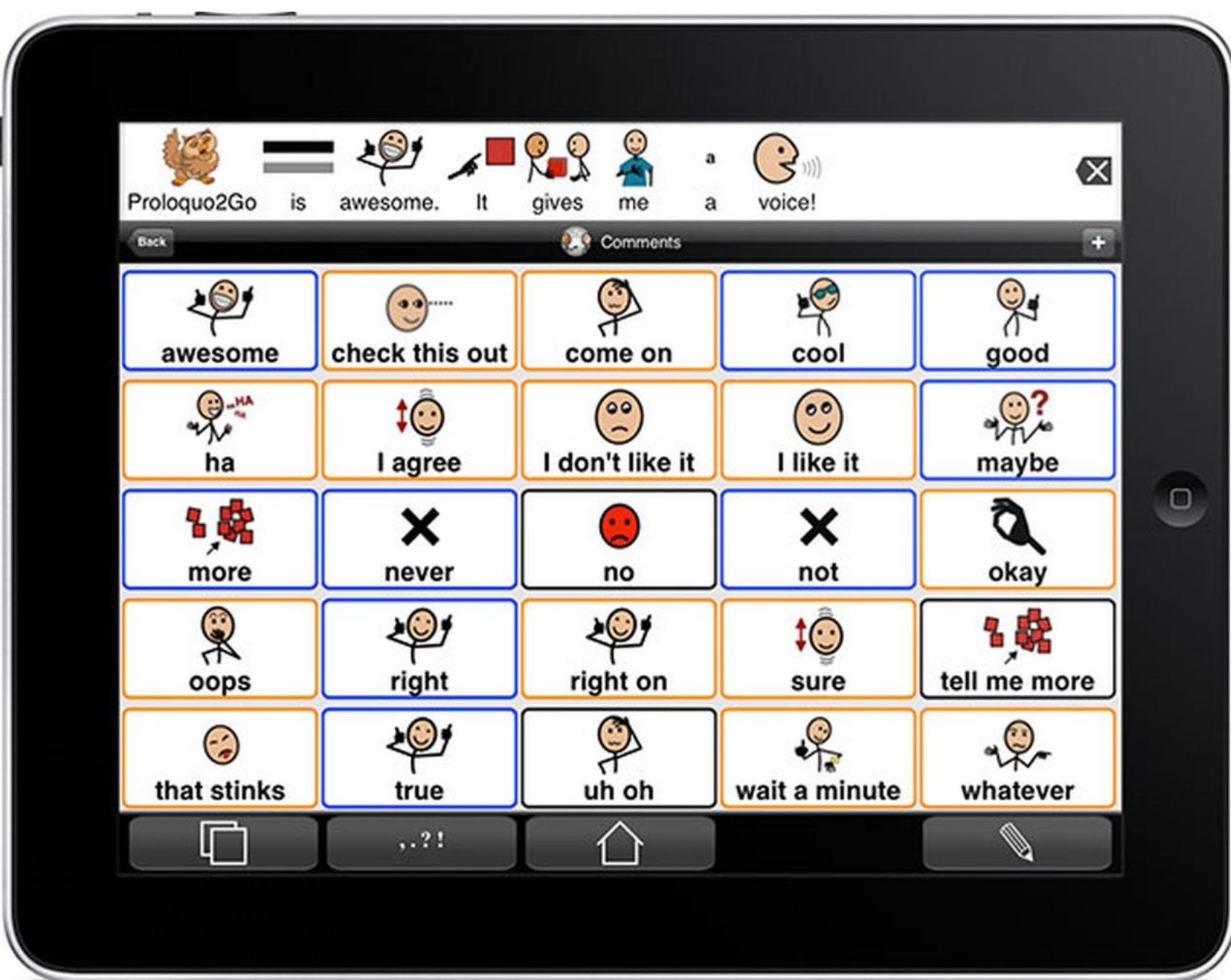
Speech input²⁷



²⁷ [Image source](#)

Alternative & Augmentative Communication²⁸

Definition: Tools that help individuals who are unable to use verbal speech to communicate.



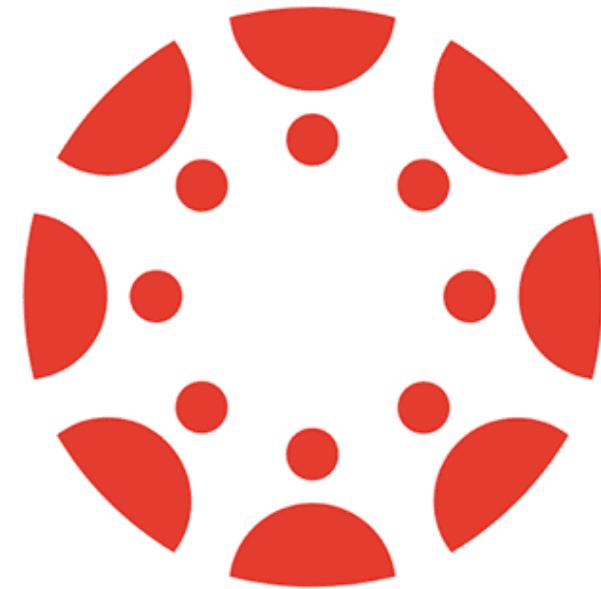
²⁸ [Image source](#)

Accessibility Testing Tools

- WAVE—evaluates the overall level of accessibility for any given website.
- Color Oracle— displays your site's colors in a manner similar to how a user with color blindness would see the page.
- Image Analyzer— examines website images and tests their compliance with accessibility standards.

Quiz 3

Complete the Canvas quiz.



canvas

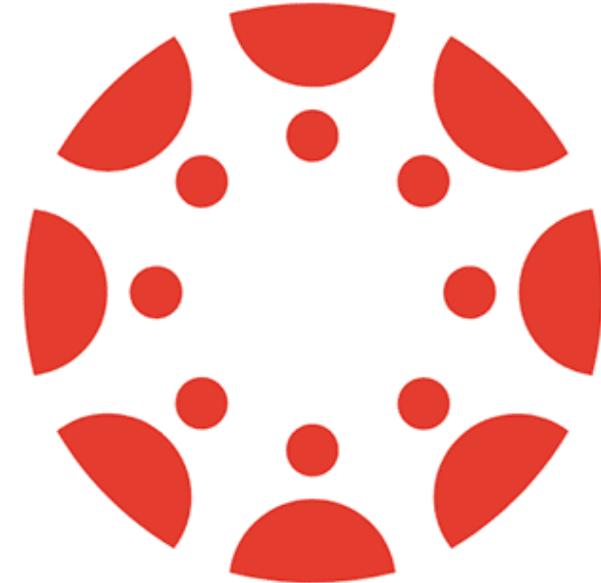
Quiz 4

Complete the Canvas quiz.

Try out an assistive technology:

1. **Task 1:** Purchase a new iPhone on the Apple site.
2. **Task 2:** Send a new email to Apple support.

Report on an observation.



canvas

How to Navigate with VoiceOver

²⁹Video source



What did we learn today?

- What is accessibility?
- Accessible design
- Assistive technologies