

Barbara Spiecker



ATOMIC HANDS

www.atomichands.com

STEM UNLOCKED

The Mechanics of Sign and Syntax

IDHHC Interpreter Conference

April 25 - 26, 2026



Atomic Hands
Executive Director

BARBARA
SPIECKER



THIS SPACE IS...

SAFE

- Everyone belongs here
- **No judgement**
- Ask questions or share thoughts/comments ANY time throughout the training
(WE LOVE THEM!)

DEAF-FRIENDLY

- Please use **ASL at all times**
- Raise your hand when you want to say something and we will copy sign for everyone

COLLABORATIVE

- This is an opportunity for all of us to **play, practice, and grow** together
- Please be mindful of various learning and engagement styles
- Equal participation during group work

GETTING TO KNOW OUR AUDIENCE



STEM-RELATED ISSUES IN DEAF EDUCATION

- What do you love about STEM?
- What do you struggle with related to STEM?
- What are some of the STEM teaching/interpreting challenges you have seen or experienced?
- What does STEM discussions in ASL look like?
- What kind of responsibility do we have to ourselves and to ASL regarding our communication about STEM topics through ASL?

WHY DO WE FIND STEM CHALLENGING?

- Too hard
- Too boring
- Dry
- Jargon-y
- Rote memorization
- Weak science communication skills
- Lack of connections between science and the real world
- “Persist or Perish” culture



Why do you think Deaf students might find STEM challenging?

- Information are often being presented inconsistently and conceptually inaccurate
 - Fingerspell
 - Invent signs on the fly
 - Different sign every time
 - Avoid discussing the topic entirely



VOCABULARY (IN ENGLISH)

- Lens
- Eyeball
- Pupil
- Cornea
- Iris
- Retina
- Brain
- Image
- Thickness
- Inward/Outward
- Dilation
- Contraction
- Superior rectus muscle
- Inferior rectus muscle
- Lateral rectus muscle
- Medial rectus muscle
- Lazy eye / Amblyopia

THE CURIOUS CASE OF BILINGUAL LEARNERS

- **Common belief:**
 - English is superior to ASL
- We often try to cram English in ASL to make sure Deaf students succeed in an English-dominated space



**Most students are asked to
perform cognitive tasks in
one language at a time**

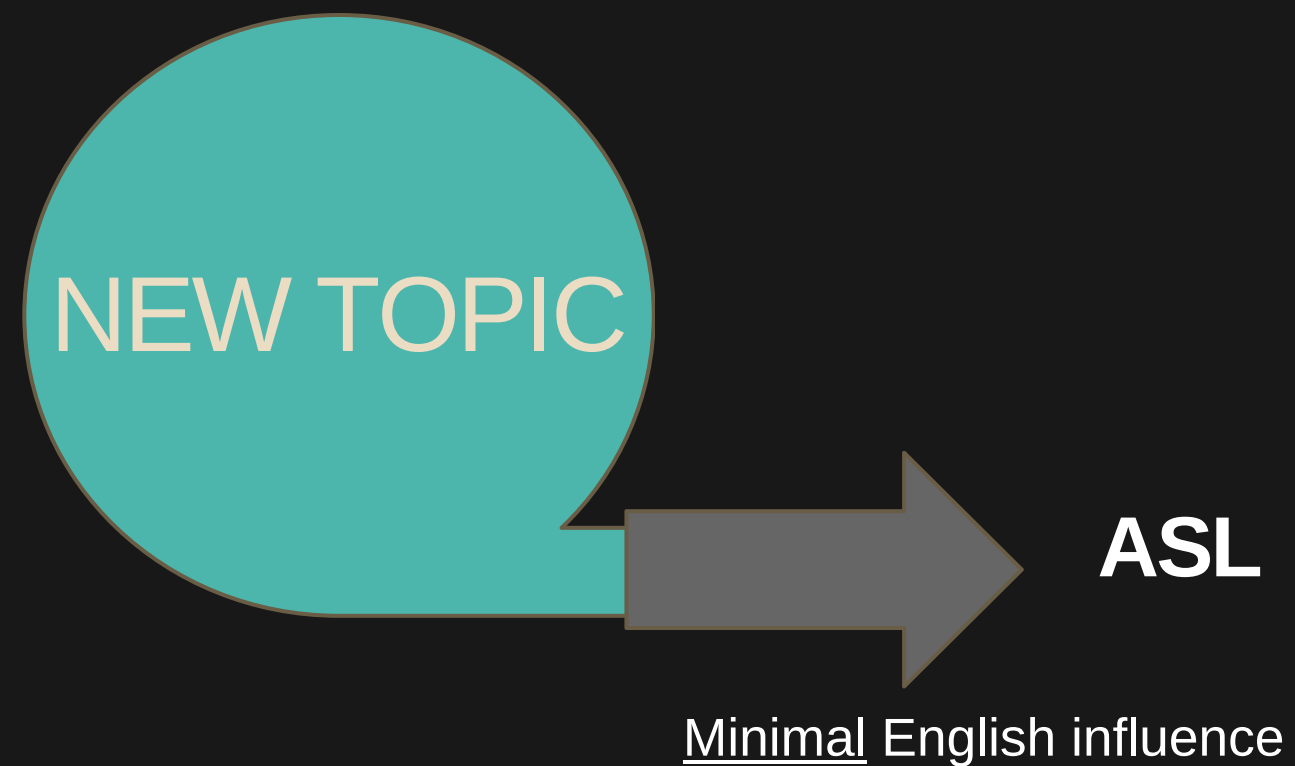
THE CURIOUS CASE OF BILINGUAL LEARNERS

- **Not in the case of deaf students!**
 - Fingerspelling English words
 - Heavy use of initialized signs
 - Signing in English Word Order

Language challenge begins at early age and continues throughout adulthood

OUTSIDE OF ACADEMIA

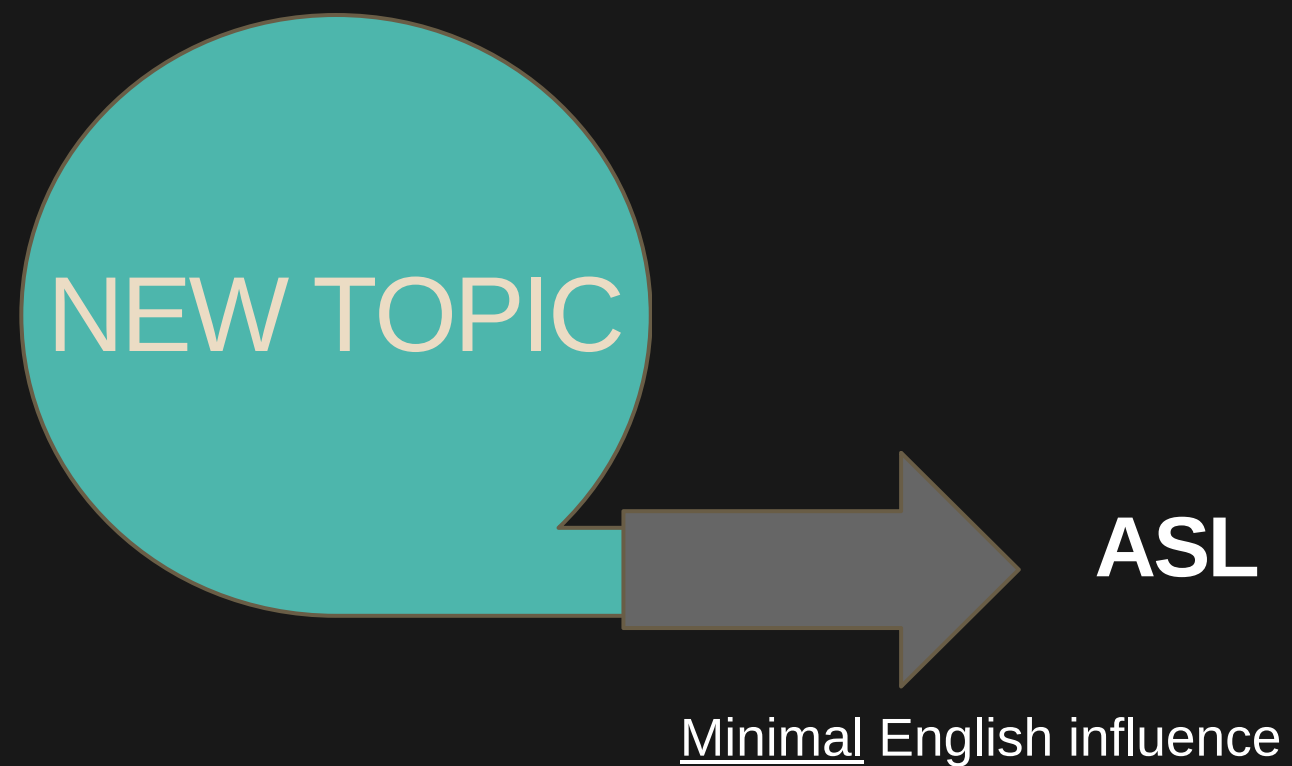
Goal: Message transmission



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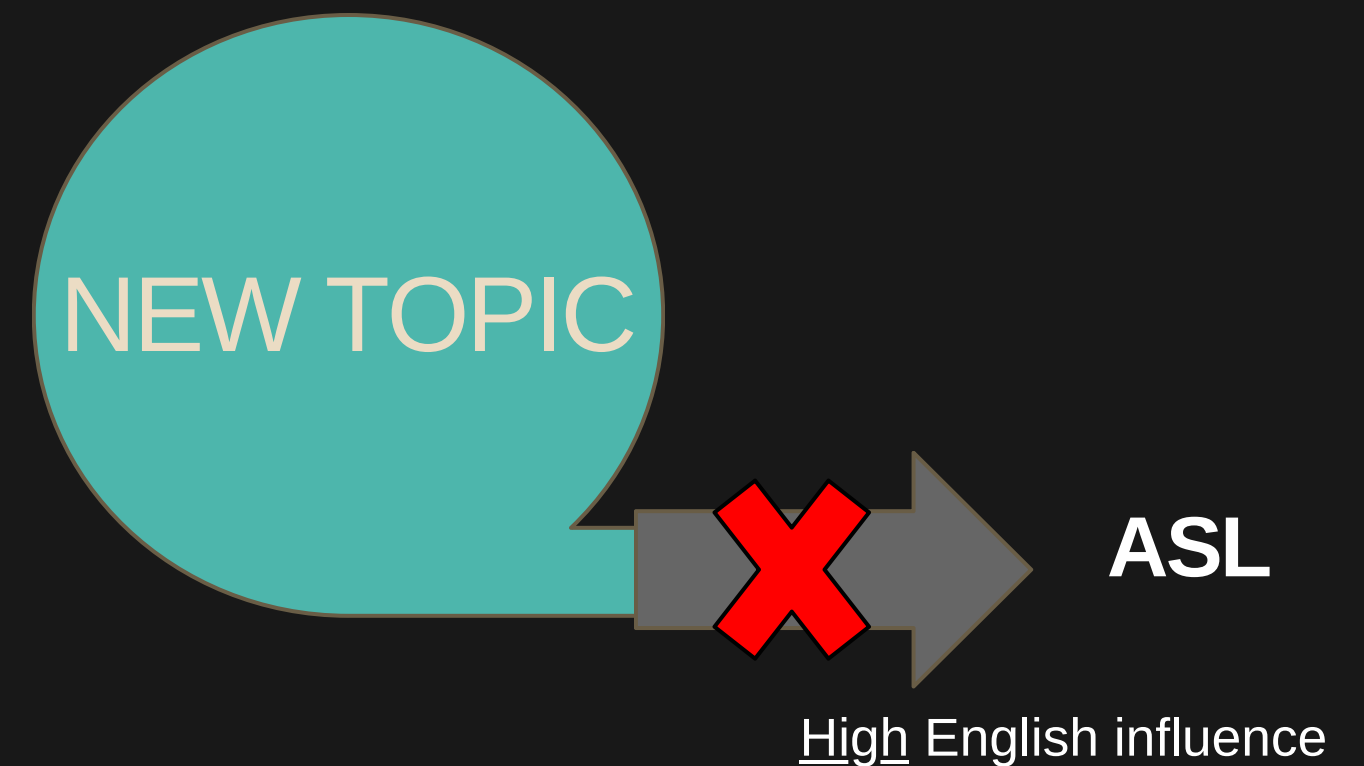
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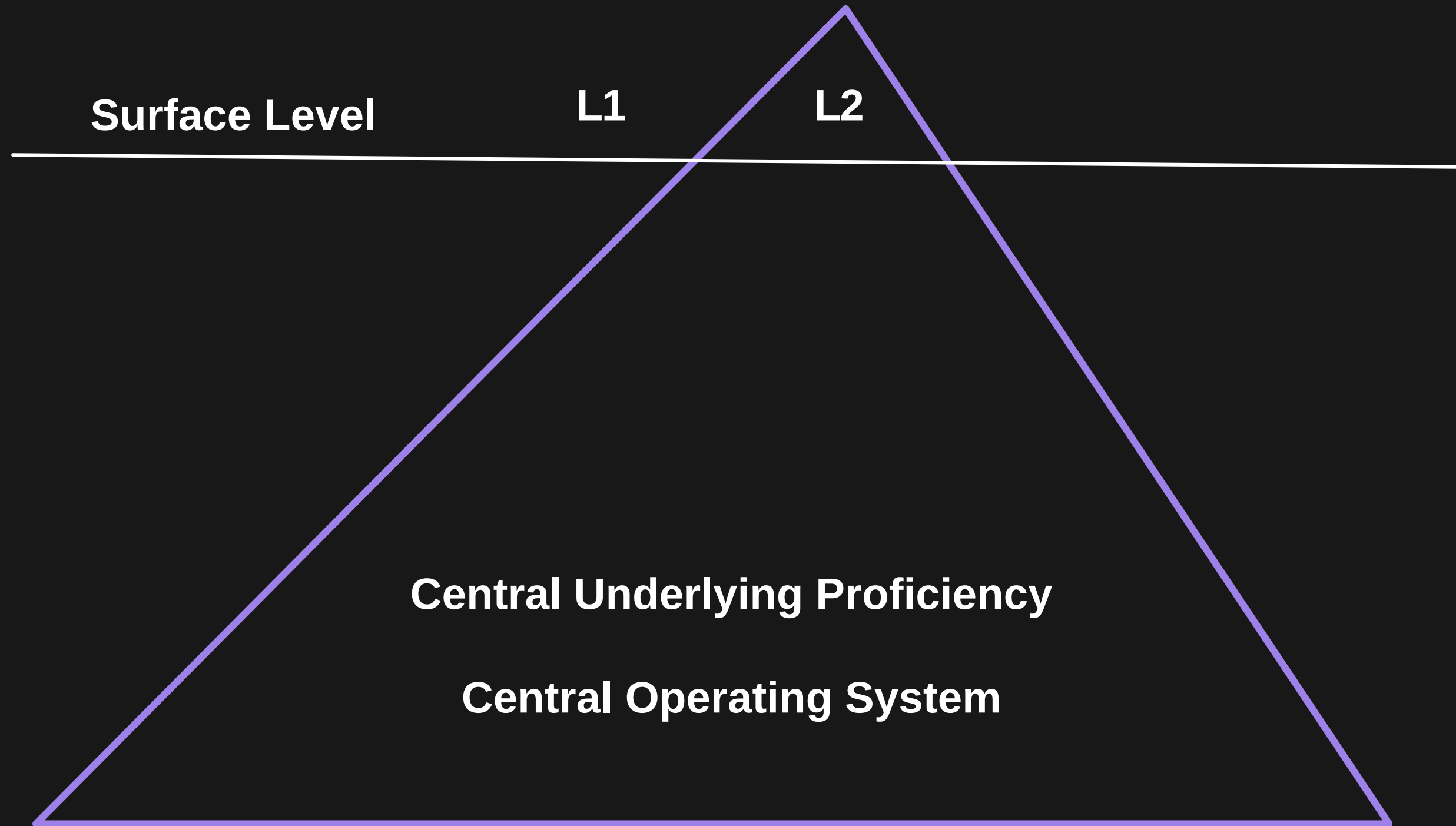
IN ACADEMIA

Goal: Learn through English



LANGUAGE BUILDS LANGUAGE

The Iceberg Analogy



ASSIMILATION VS. INTEGRATION

ASSIMILATION

- Trying to adapt to the monolingual English-dominated environment
 - Signing English Word Order
 - Fingerspelling
 - Using initialized signs
- Loss of identity

INTEGRATION

- Embracing bilingualism and honoring both languages (ASL and English)
 - Designated time for each language
 - Thoughtfully crafted delivery of information in ASL with language scaffolding and bridging to English when appropriate
- Retention of identity and culture

ASSIMILATION VS. INTEGRATION

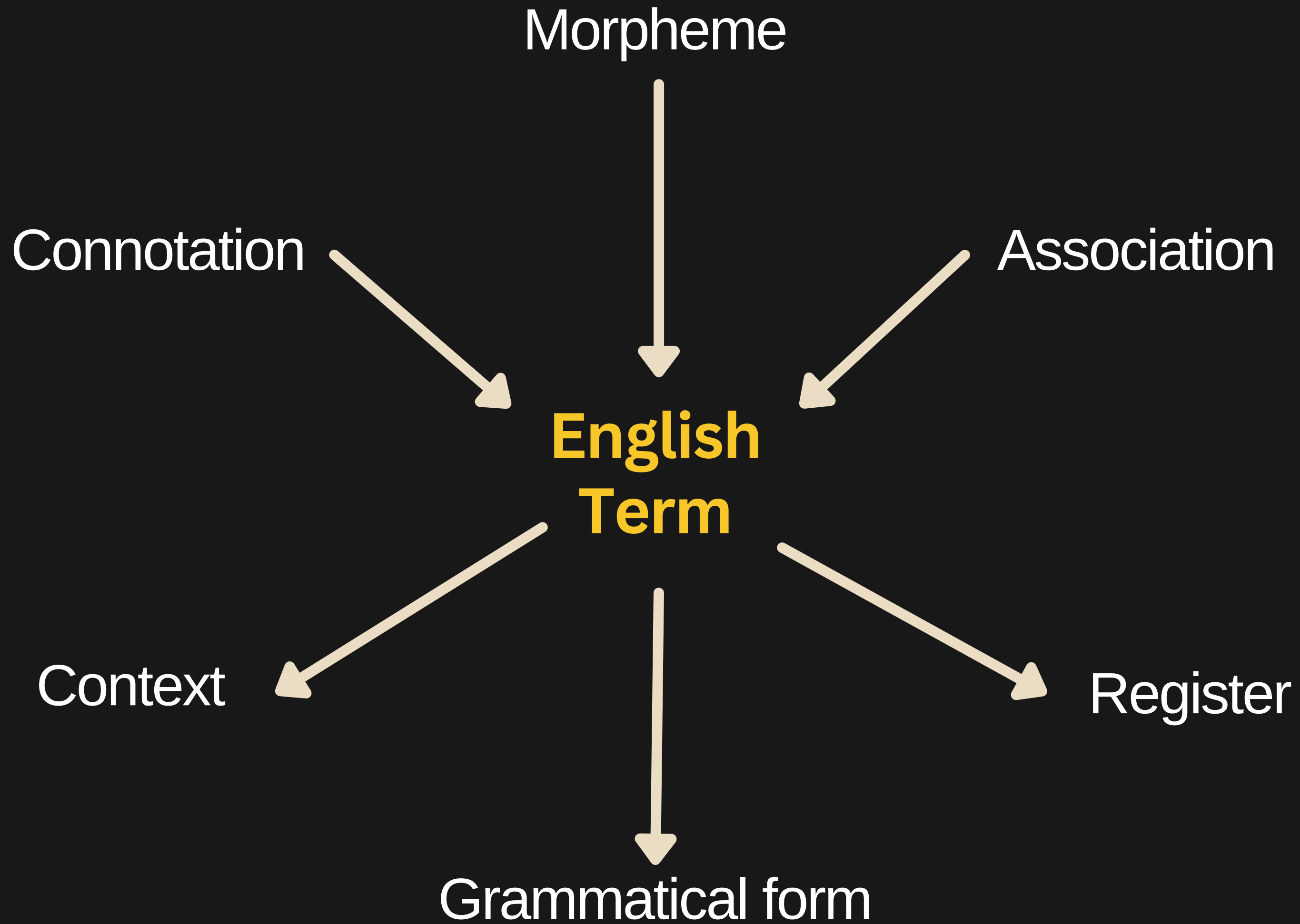
ASSIMILATION

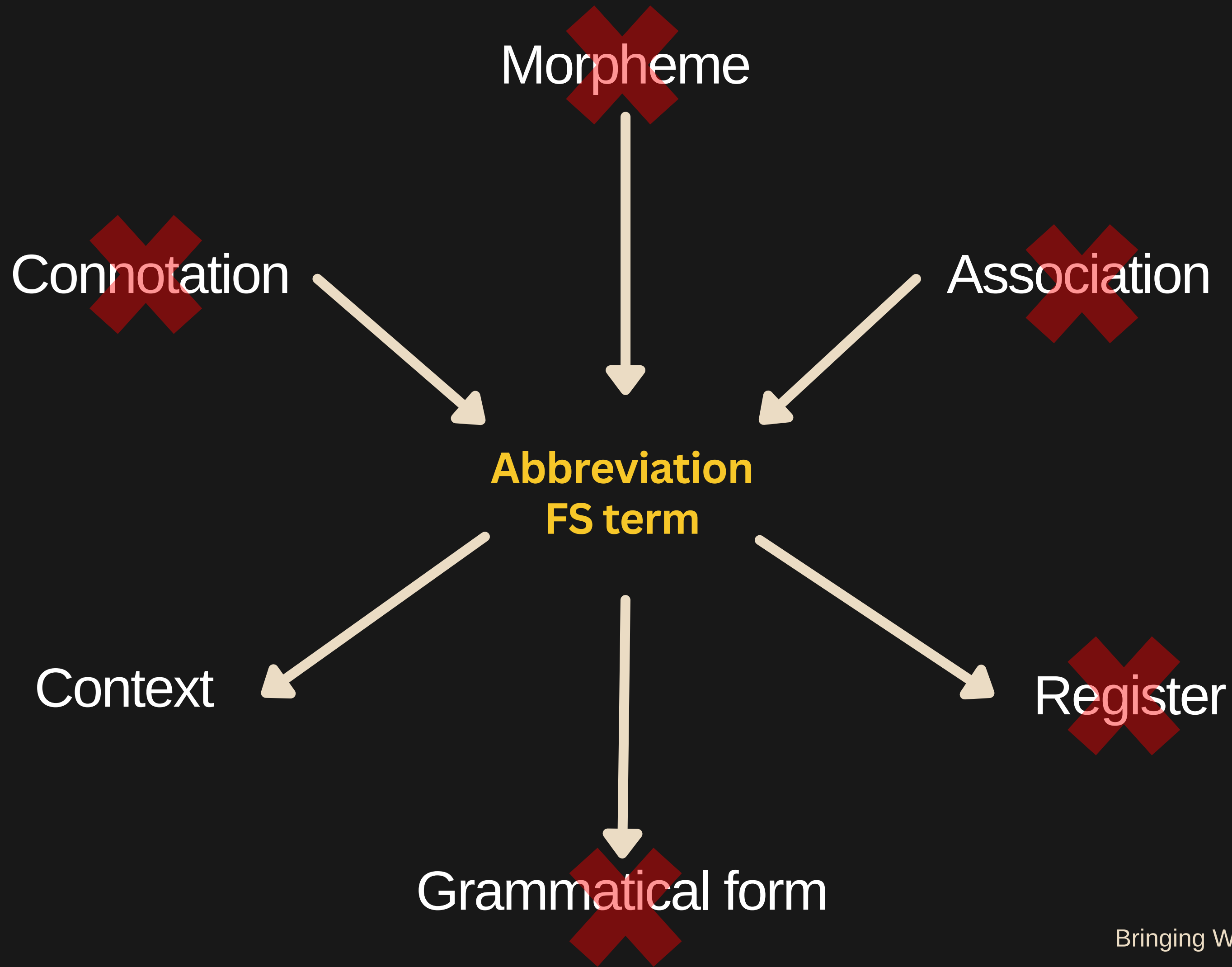
- Trying to fit into the monolingual English-dominated environment
 - Sign language Word Order
 - English grammar rules
- Loss of identity

INTEGRATION

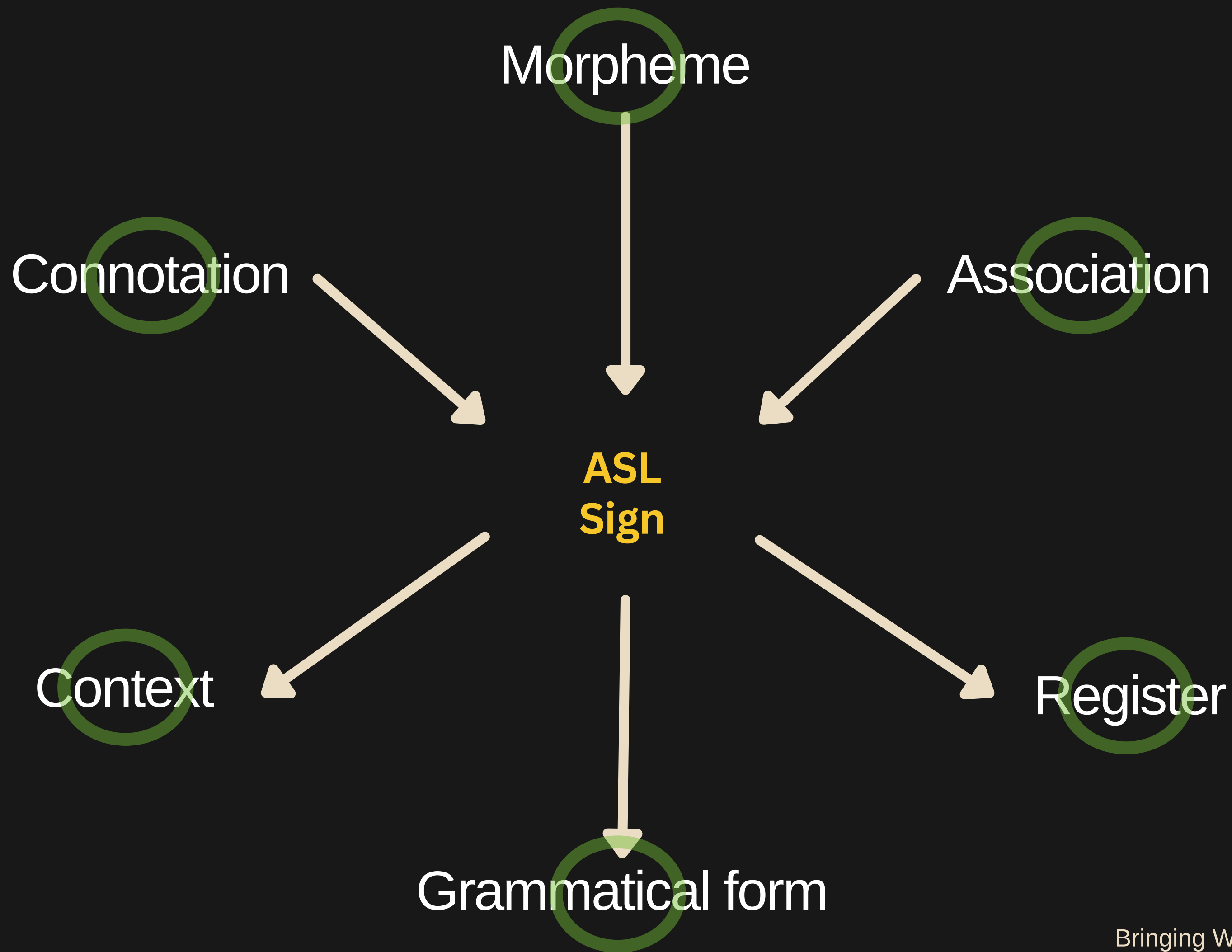
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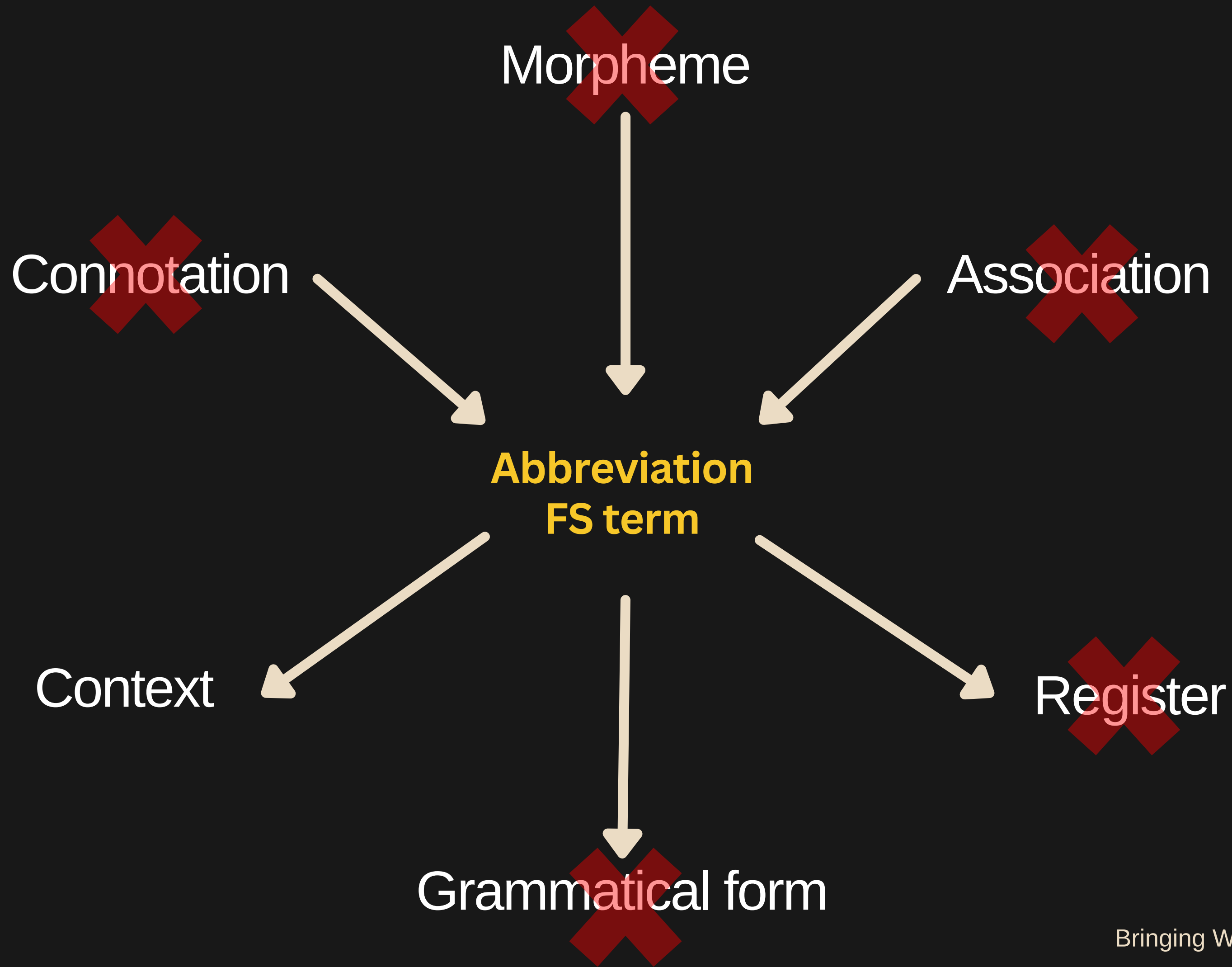




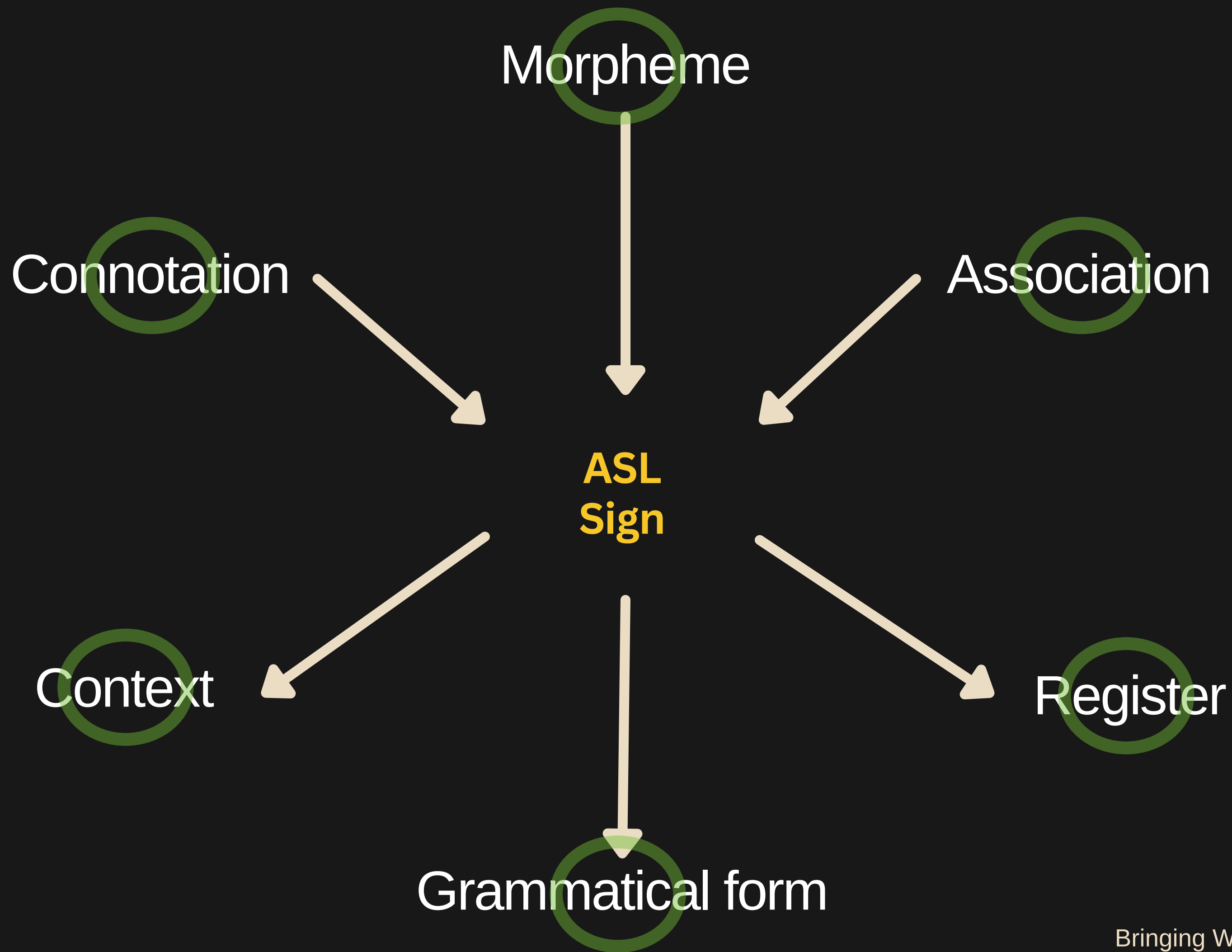












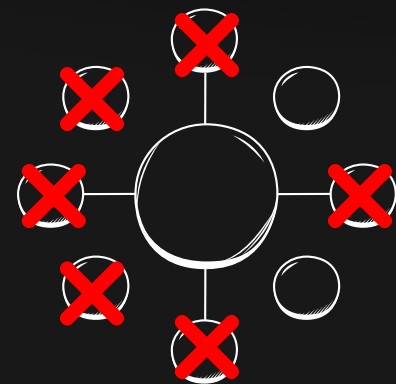
THE ANATOMY OF SIGNS

- Informative vs Non-Informative Signs

Non-Informative Sign

Few or None

meaningful linguistic or contextual features

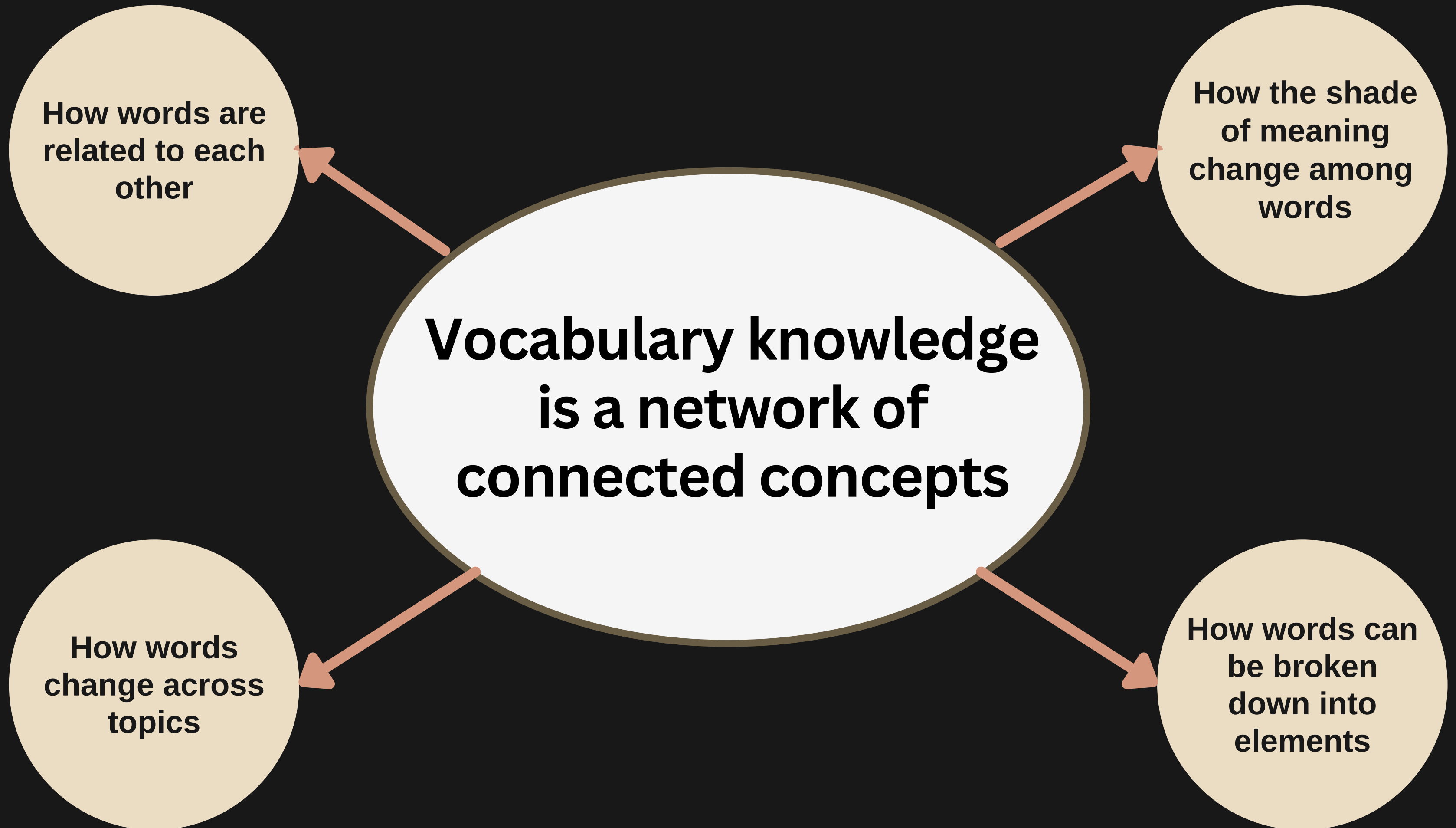


Informative Sign

Many

meaningful linguistic or contextual features





**Words might change from
language to language...**

**Words might change from
language to language...**

But the concepts remain the same.



**STEM concepts do not
belong to English**

$$E=MC^2$$

THE >> SECRET << TO THE MAGIC OF STEM

Three-pronged approach:

1. **Vocabulary** -- *Meaningful signs*
2. **Discourse** -- *Engaging and relatable message*
3. **Knowledge** -- *Understanding of the topic*



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THE >> SECRET << TO THE MAGIC OF STEM

Three-pronged approach:

1. **Vocabulary** -- *Meaningful signs*

- **Consider all elements of a sign**
 - Connotation
 - Morpheme
 - Association
 - Register
 - Grammatical form
 - Context
- **Relationships of concepts**
 - How one sign is related to another

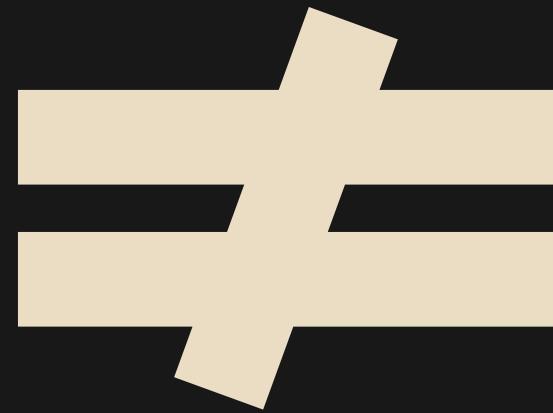


MIND & BODY BREAK

Please be back in 5 minutes

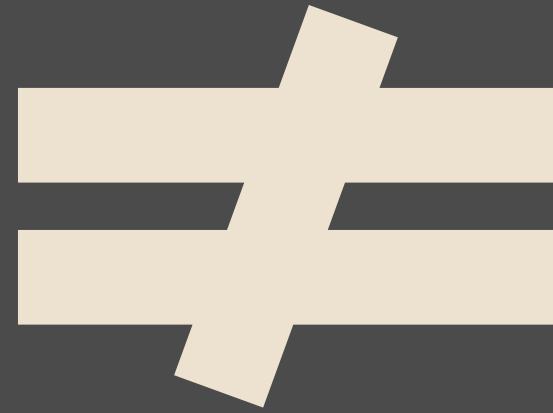
No DST

**Creating
STEM signs**



**Purifying
ASL**

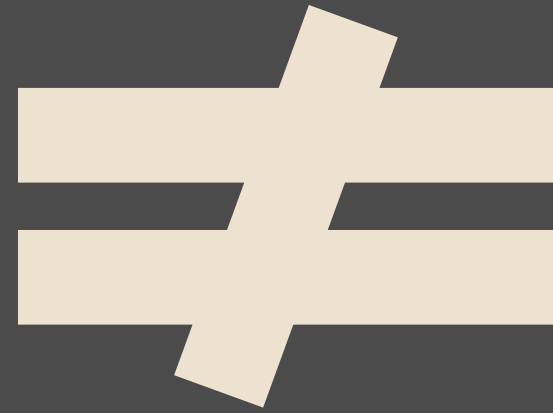
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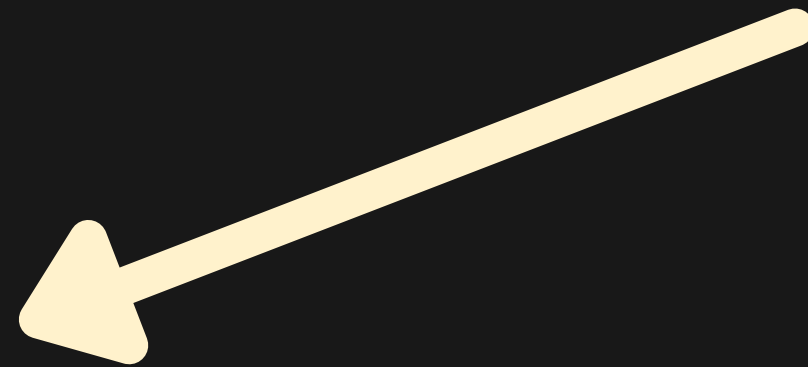
Re-evaluation of how we discuss STEM topics in ASL

**Creating
STEM signs**



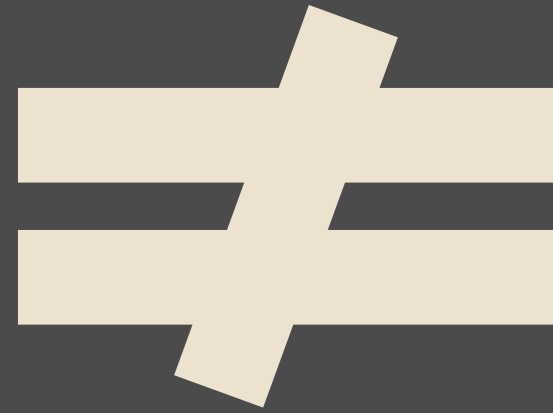
**Purifying
ASL**

Re-evaluation of how we discuss STEM topics in ASL



**Are our signs being
colonized by English?**

**Creating
STEM signs**



**Purifying
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Re-evaluation of how we discuss STEM topics in ASL

**Are our signs being
colonized by English?**

**Can some of the current signs
used in social settings apply to
academic settings?**

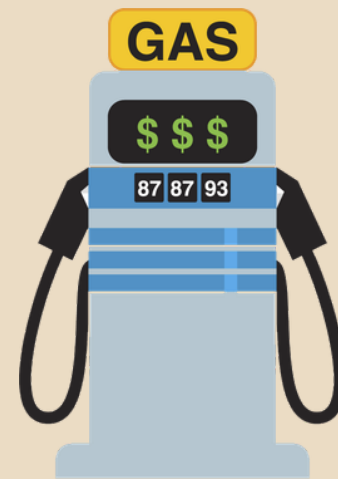
EXISTING SIGNS DON'T ALWAYS REPRESENT THEIR MEANING

*Signs we use in social conversational settings
may have a different meaning in STEM*

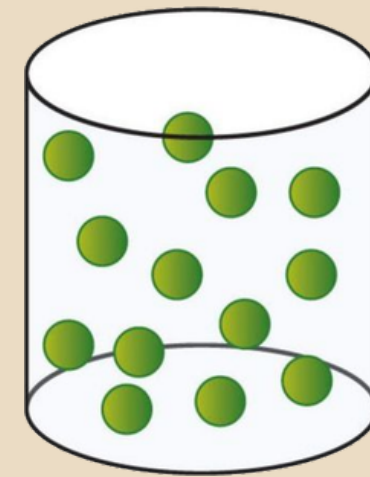
EXAMPLE:

gas

CONSUMER



TECHNICAL



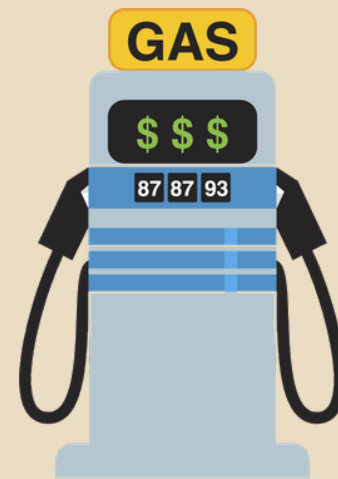
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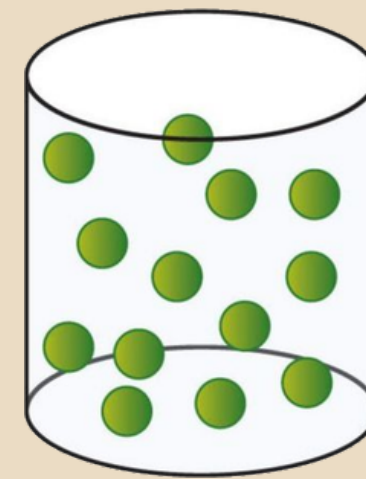
EXAMPLE:

gas

CONSUMER



TECHNICAL



Can you think of other examples?

EXISTING SIGNS DON'T ALWAYS REPRESENT THEIR MEANING

In some cases...

- There is a **clear distinction** between consumer vs technical signs
- Signs do **not** share the same meaning

EXISTING SIGNS DON'T ALWAYS REPRESENT THEIR MEANING

In some cases...

- There is a **clear distinction** between consumer vs technical signs
- Signs do **not** share the same meaning

In other cases, not so much...

- Cases where consumer and technical concepts **exist together**
 - **Ex.** Medical settings with healthcare professionals and patients
- Signs **may** share the same meaning

DILEMMA #1: FORM VS. FUNCTION

- **Form** → what the object looks like
 - **Ex.** Tree, Table, Cup
- **Function** → the activity or purpose of the object
 - **Ex.** Car, Knife, Vacuum

DILEMMA #1: FORM VS. FUNCTION

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In medical settings...

- Can we use **one sign** to represent the **same meaning** when interacting with patients and with healthcare professionals?
 - **Ex.** Oxygen (tube vs. molecule)

DILEMMA #2: SYMBOL VS. WORD/SIGN



- **Community consensus:**
 - Signs are determined by meaning, not by their association with English words
 - **Ex.** Run

DILEMMA #2: SYMBOL VS. WORD/SIGN









- **Community consensus:**
 - Signs are determined by meaning, not by their association with English words
 - **Ex.** Run
- **But!** What about cases like those seen in **math-related settings?**
 - **Ex.** Signing a symbol vs. signing a concept

DILEMMA #2: SYMBOL VS. WORD/SIGN

Mathematical Concept	
Math Symbol	English Word
ρ	density

Math Symbol in ASL	ASL Sign
	

Mathematical Concept

Math Symbol	Math Symbol in ASL	ASL Sign
$+$		
$-$		
\times		
\div		

DILEMMA #2: SYMBOL VS. WORD/SIGN

Written Equation:

$$7 + 3 = 10$$

Mathematical Concept

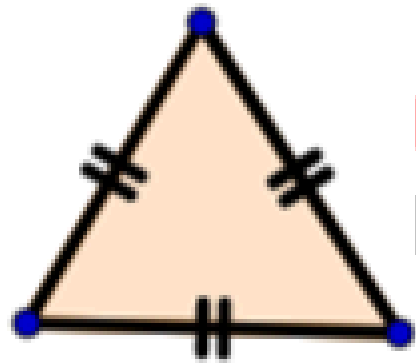
Math Equation in ASL

ASL Signs

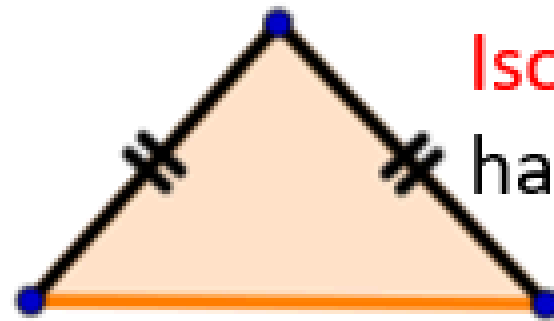
$$7 + 3 = 10$$

7 3 ADD, EQUAL 10

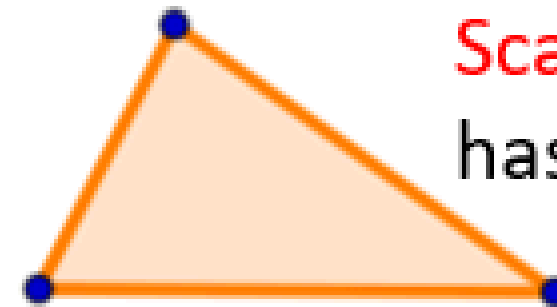
ARE WE GIVING AN ANSWER WITH ASL SIGNS?



Equilateral Triangle
has three equal sides



Isosceles Triangle
has two equal sides



Scalene Triangle
has no equal sides

ROOT SIGNS REINFORCES CONSISTENCY AND RELATIONSHIPS



MOLECULE

ROOT SIGNS REINFORCES CONSISTENCY AND RELATIONSHIPS



MOLECULE



IONIC BOND



COVALENT BOND

ROOT SIGNS REINFORCES CONSISTENCY AND RELATIONSHIPS



MOLECULE



IONIC BOND



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ENERGY

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ENERGY

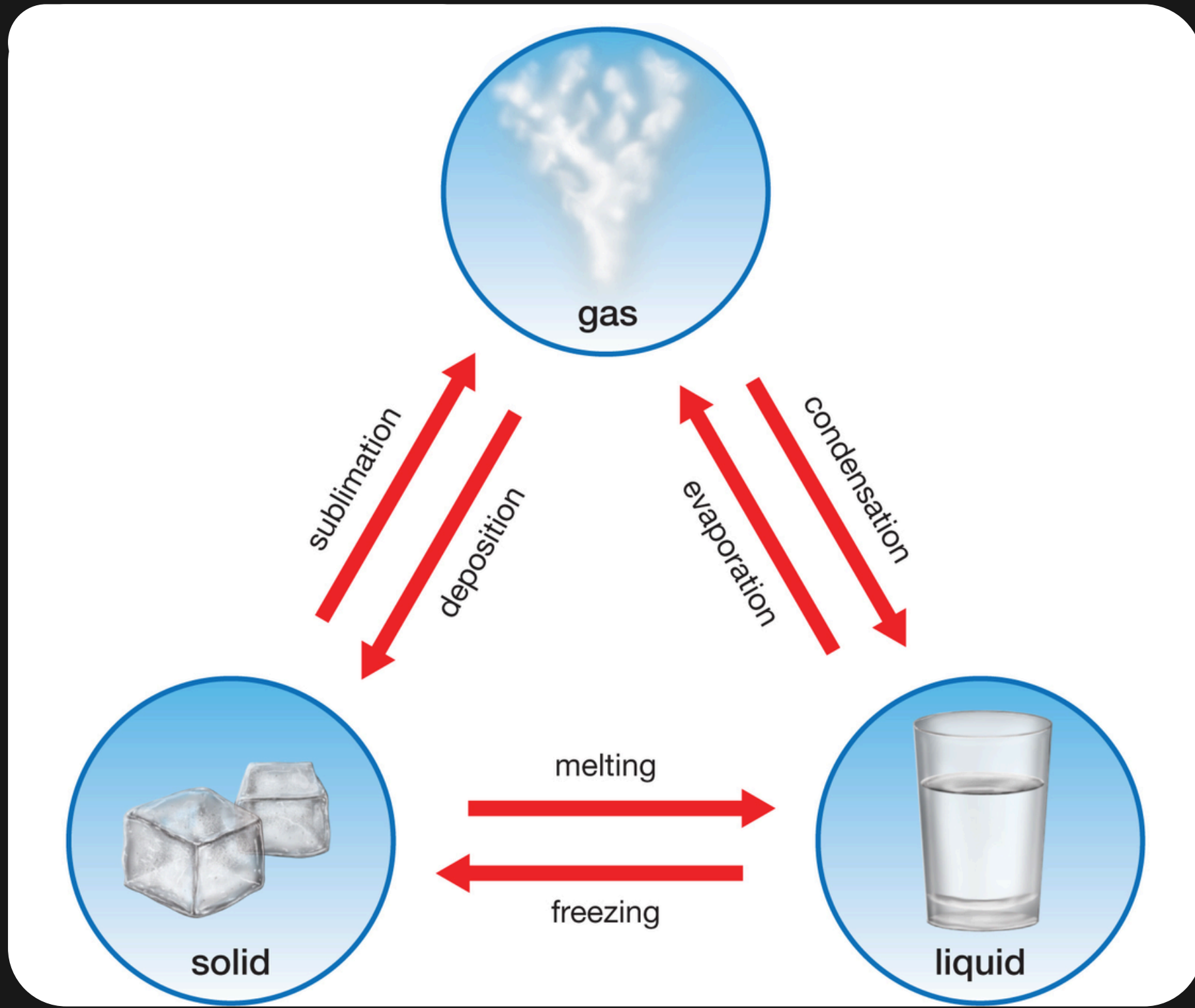


POTENTIAL ENERGY



KINETIC ENERGY

STATES OF MATTER



THE ANATOMY OF SIGNS

- Nouns vs Verbs

Noun

- Double Repetition
- Compound Structure
- Assimilation

Verb

- Single Movement
- Action-Oriented

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Semicircular
Canals

THE ANATOMY OF SIGNS

- Nouns vs Verbs

Noun

- Double Repetition
- Compound Structure
- Assimilation



Mastoiditis

THE ANATOMY OF SIGNS

- Nouns vs Verbs

Noun

- Double Repetition
- Compound Structure
- Assimilation



Heart Attack

THE ANATOMY OF SIGNS

- Nouns vs Verbs

Verb

- Single Repetition
- Action-Oriented



Verb-like

THE ANATOMY OF SIGNS

- Nouns vs Verbs

Verb

- Single Repetition
- Action-Oriented



Verb-like

VS



Noun

THE ANATOMY OF SIGNS

- Nouns vs Verbs

Verb

- Single Repetition
- Action-Oriented



Verb-like

THE ANATOMY OF SIGNS

- Nouns vs Verbs

Verb

- Single Repetition
- Action-Oriented



Verb-like

VS



Noun

STEM COMMUNICATION IS THE **KEY** TO CONCEPTUAL CLARITY

STEM communication makes STEM topics more **accessible** and **engaging**

- Communicate concepts clearly and intentionally → **easier to visualize**
- Each meaning is unique and has a place in a particular context
- Intentional choices of signs → **clear, engaging message**

DILEMMA #3: HOW DO WE EVALUATE STEM SIGNS?

We are in a transition period....

- Which means STEM signs are **ever-changing**
- Some signs will be completely new, modified from the old, or discarded entirely.

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 - Signs that we need time to learn

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We are in a transition period....

- Which means STEM signs are **ever-changing**
- Some signs will be completely new, modified from the old, or discarded entirely.
- We need to **recognize** the difference between:
 - Signs that are incompatible
 - Signs that we need time to learn
- How do we recognize which sign **work** and which **does not**?
 - Lean into your language intuition
 - Discuss with other people
 - Practice

“Language use and evolution cannot be dictated by the few, no matter their expertise. Instead, languages change because their users choose to change them.”

ASL STEM Forum

ASL STEM SIGN DEVELOPMENT

This past decade has seen a boom of new signs in STEM fields
Still a lot of work ahead of us

Who can create signs?
deaf people

BUT!

the ASL community can support the development of STEM signs

HOW DO WE ADDRESS THE STANDARDIZATION ISSUES?

- Create a professional learning community to standardize signs on a local level
 - **CAUTION:** Signs may become outdated and create a mismatch with nationwide trends

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 - They can handle various versions of a sign (up to a limit)

HOW DO WE ADDRESS THE STANDARDIZATION ISSUES?

- Create a professional learning community to standardize signs on a local level
 - **CAUTION:** Signs may become outdated and create a mismatch with nationwide trends
- Deaf students are bilingual and their minds are versatile
 - They can handle various versions of a sign (up to a limit)
- STEM signs are **novel**
 - We are currently undergoing a transition period where we are determining which signs to embed in our language

So, to answer the burning question...

how can you support the development of STEM signs?

So, to answer the burning question...

how can you support the development of STEM signs?

- We need to recognize deaf people as **drivers of change**, not as **passive recipients of change**
- Empower deaf people (students/clients/family/friends, etc.) to analyze existing signs and/or create signs.
 - You probably have more training in **ASL linguistics and language critical thinking/analytical skills** than most deaf people.
 - **USE YOUR SKILLS!** Teach deaf people these skills.
 - Give them a sense of autonomy over their language.

ASL AND STEM IN ASL ARE PREDOMINANTLY WHITE

- Newly-developed STEM signs and STEM prose in ASL are largely rooted in white values and perspectives of the world
 - This is **problematic** as it devalues other dialects, languages, and cultures
-

ASL AND STEM IN ASL ARE PREDOMINANTLY WHITE

- Newly-developed STEM signs and STEM prose in ASL are largely rooted in white values and perspectives of the world
 - This is **problematic** as it devalues other dialects, languages, and cultures
-
- Have you noticed any cultural barriers to STEM education for deaf students?
 - Are there signs and prose that are unique to your area?
 - How can we be mindful (and incorporate when appropriate) these signs and prose?

MIND & BODY BREAK

Please be back in 5 minutes

No DST

BREAKOUT GROUPS

Language play time!

Activity: Creating ASL STEM Signs

Each group will be randomly assigned a set of three related concepts and they will create a sign for each concept

Geometry
Environmental Science
Physics
Computer Science

Feel free to use the internet to learn more about the assigned concepts

BE CREATIVE!

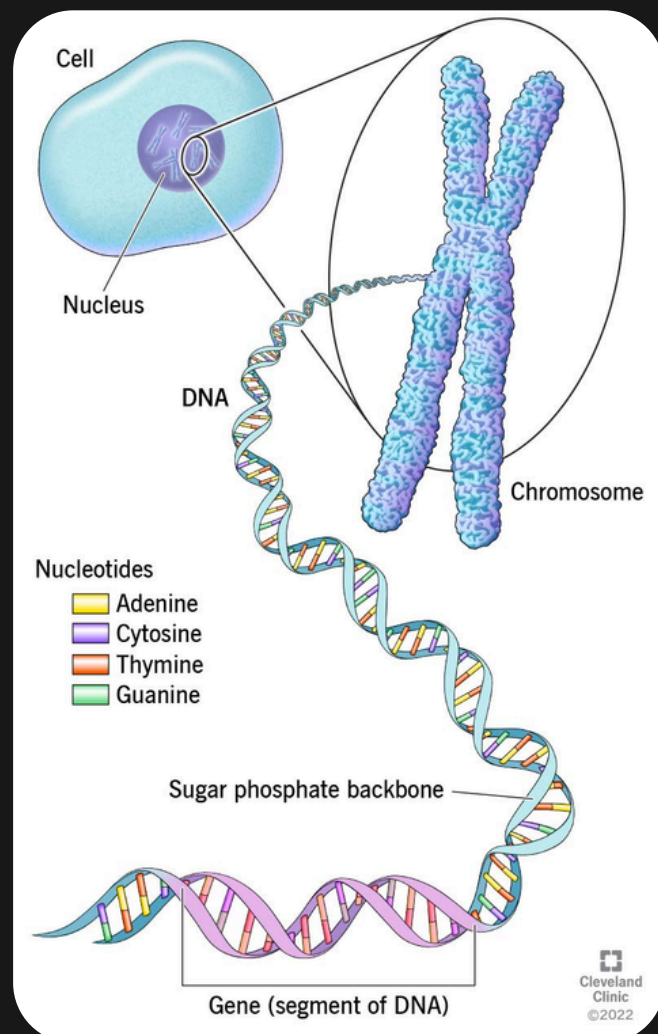
If you know of a sign, evaluate whether a better one can be created.

Activity: Create an ASL Sign (EXAMPLE)

Form groups and create a meaningful and conceptually accurate signs for your assigned terms.

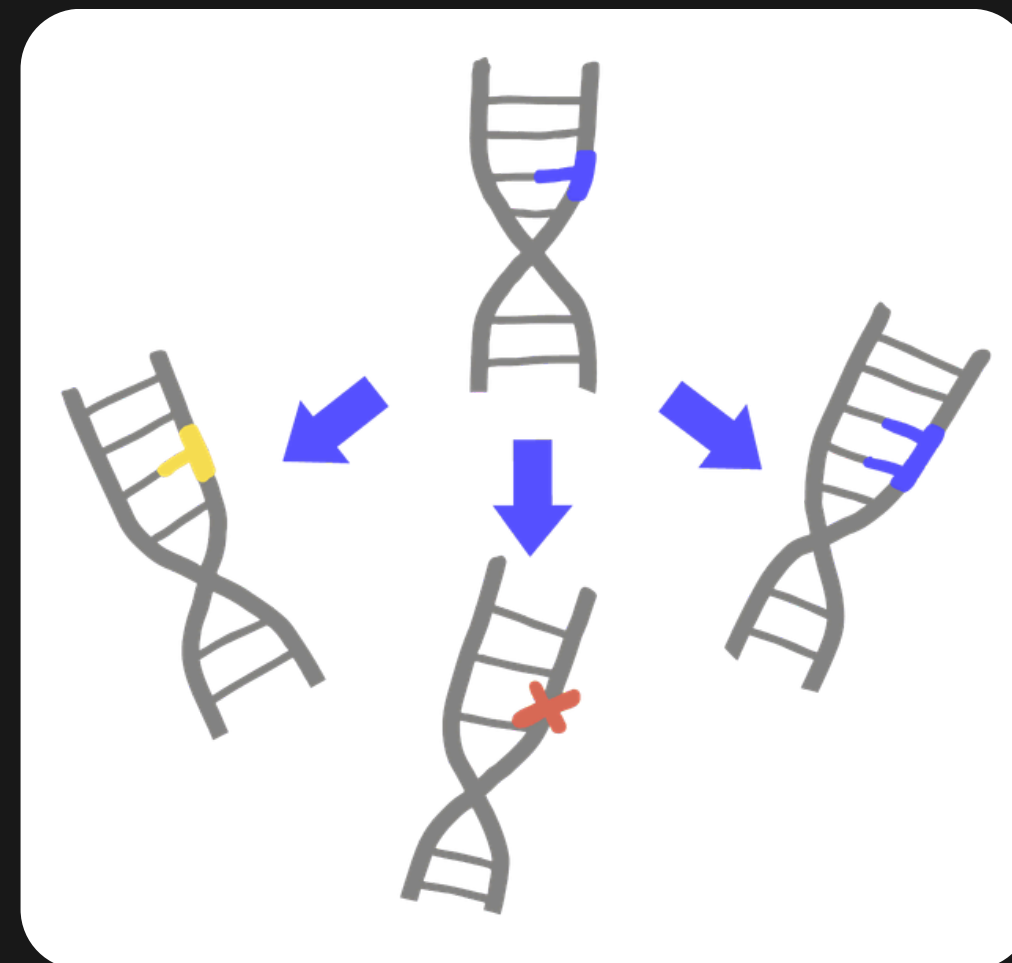
GENE

a distinct sequence of nucleotides in DNA



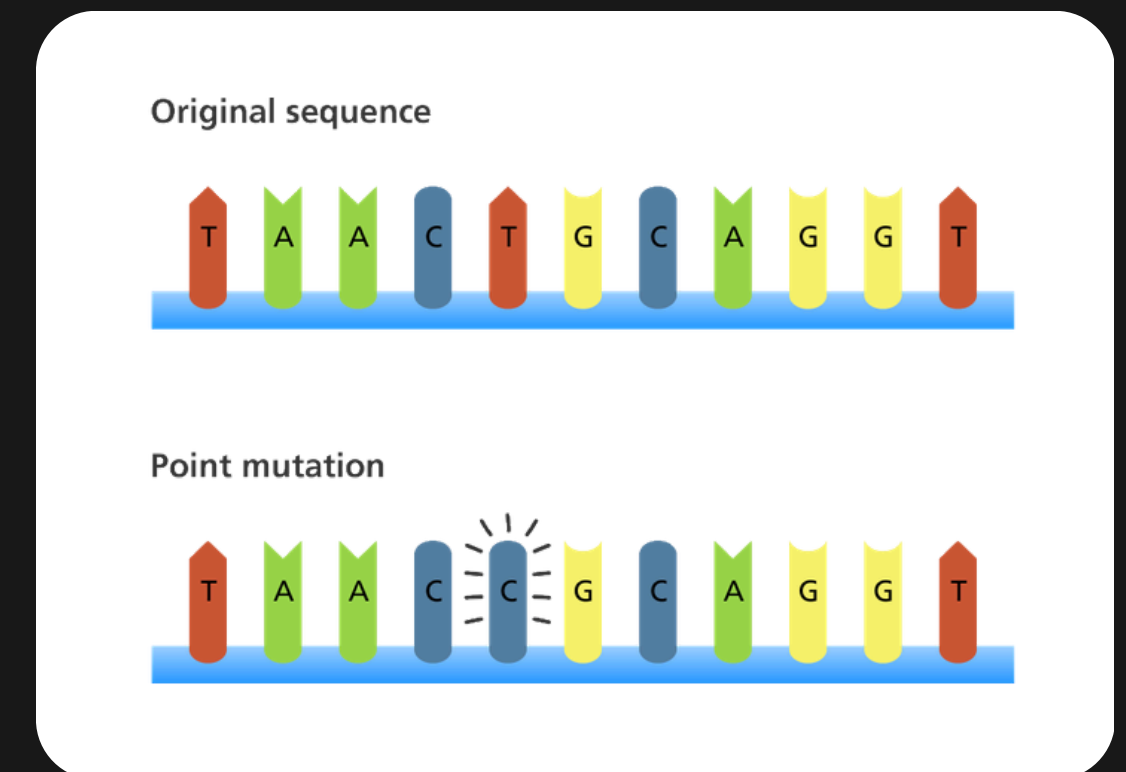
MUTATION

a change in the DNA sequence of an organism



SINGLE BASE SUBSTITUTION

a type of mutation where one base is replaced by a different base

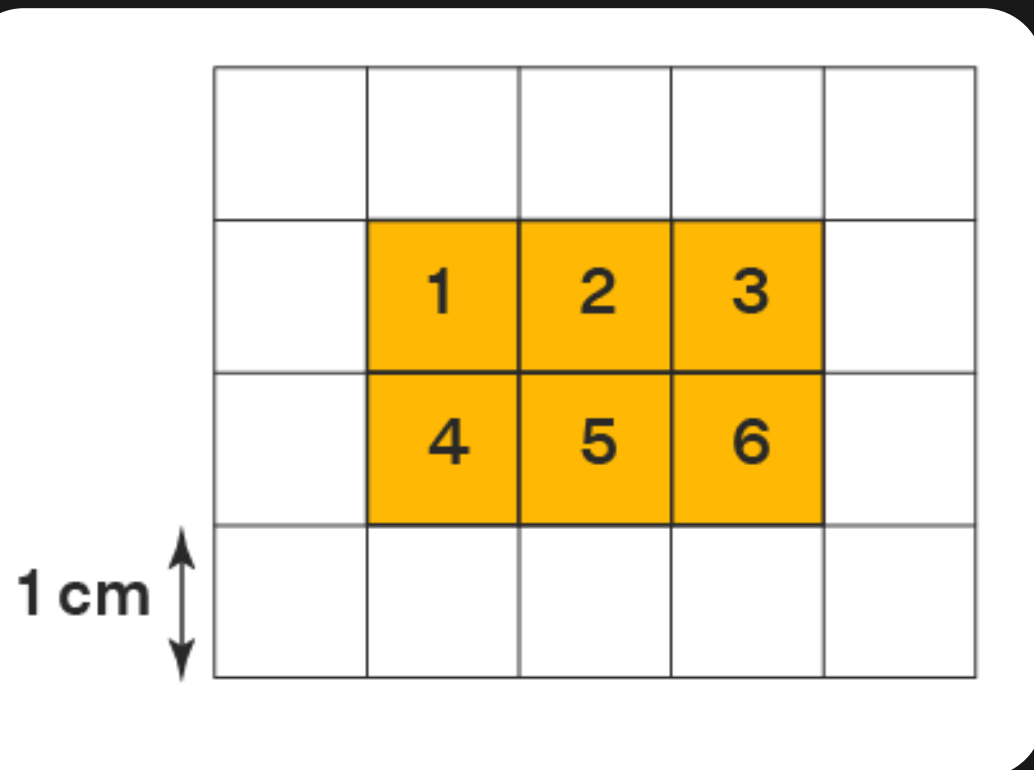


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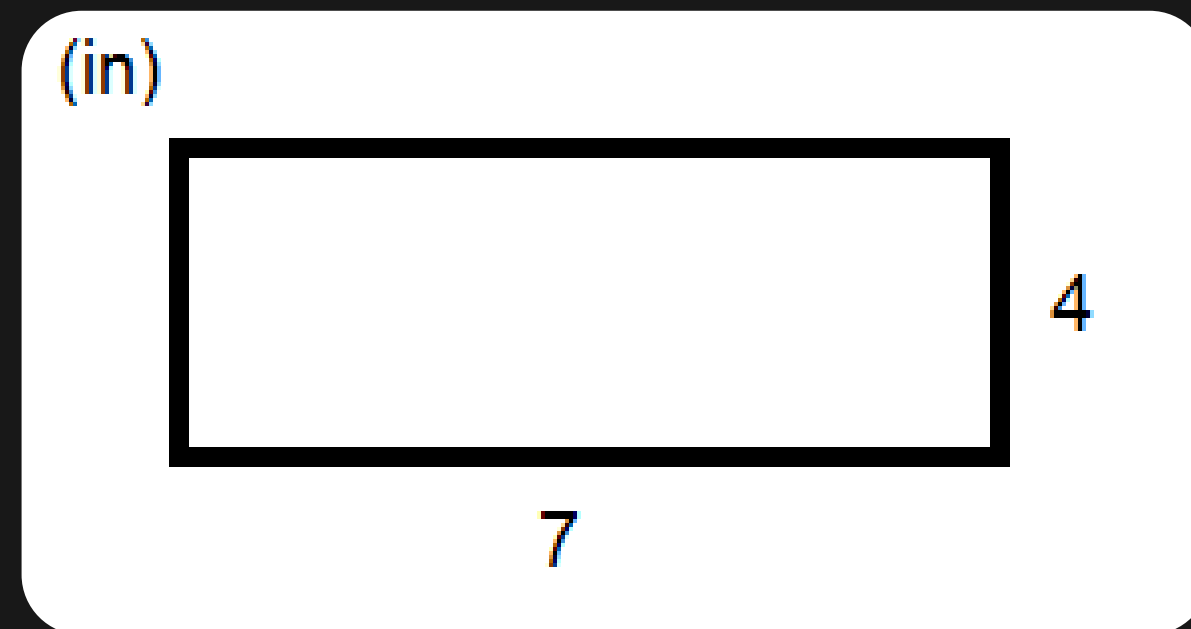
AREA

the amount of space inside a two-dimensional shape.



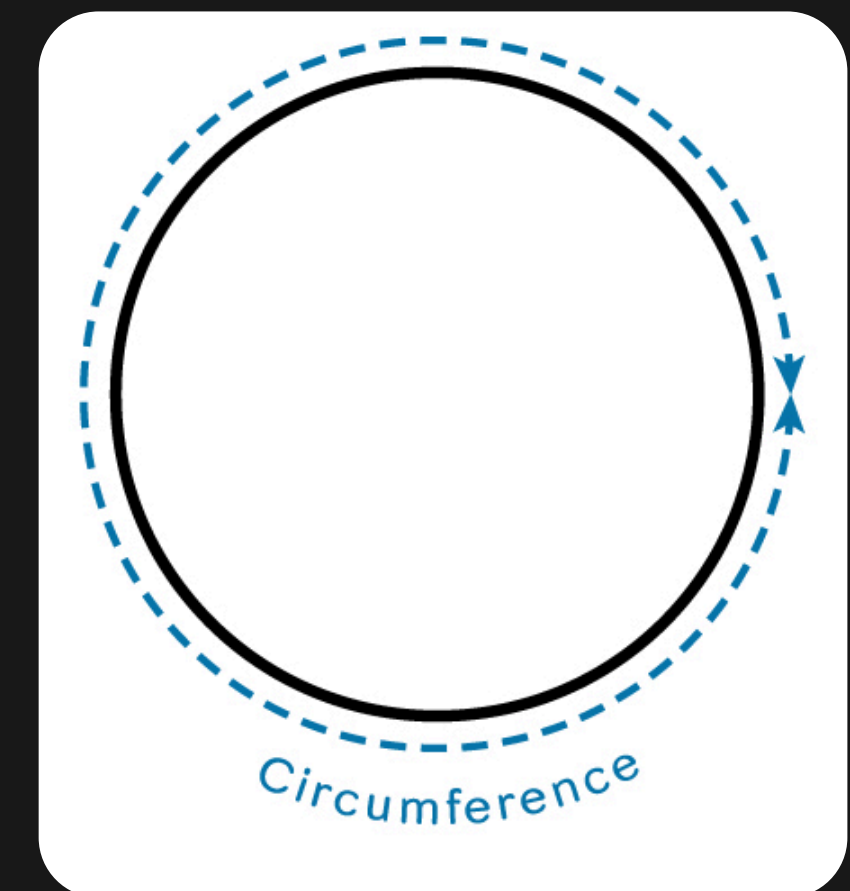
PERIMETER

the total distance around the edges of a shape.



CIRCUMFERENCE

the distance around the edge of a circle.



Activity: Create an ASL Sign

Form groups and create a meaningful and conceptually accurate signs for your assigned terms.

FRESH WATER

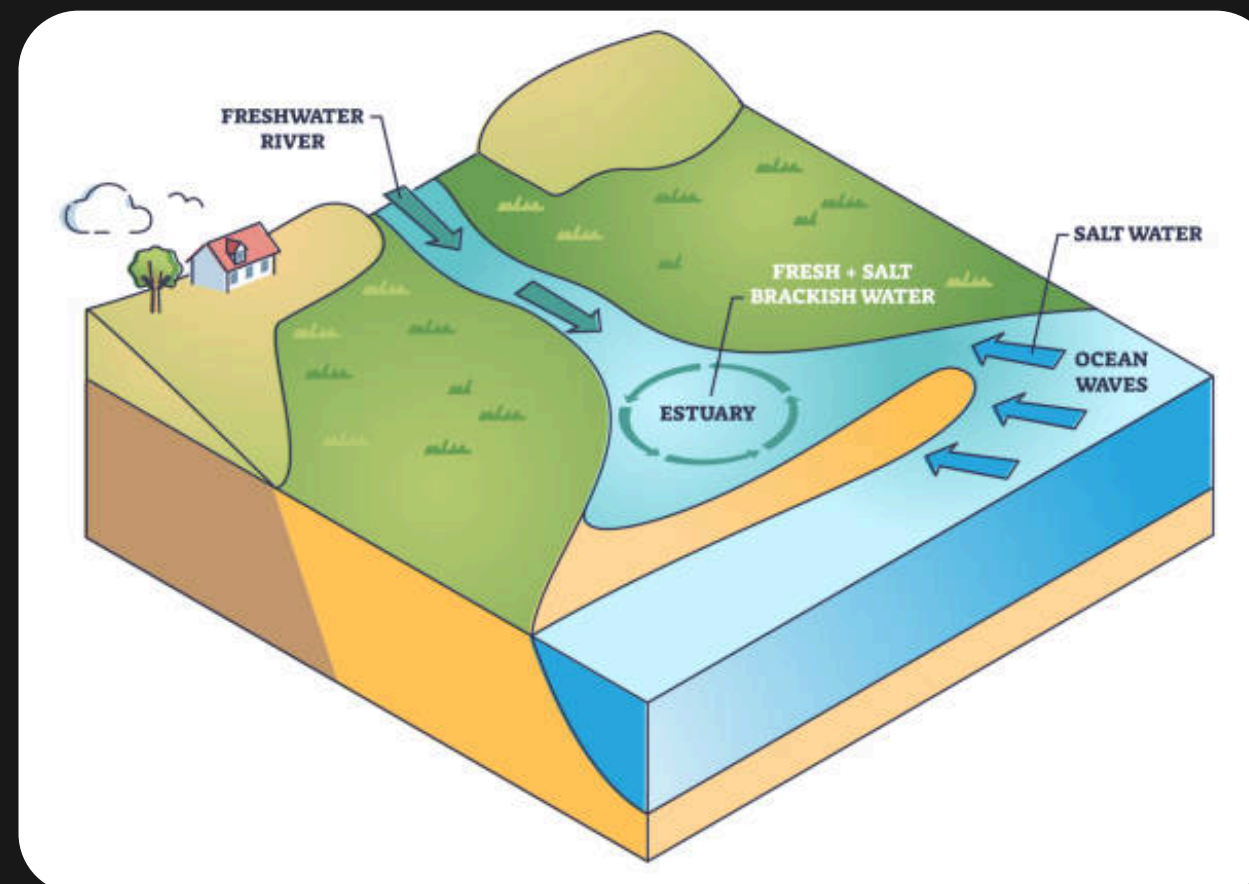
naturally occurring water
that is not salty

SALT WATER

naturally occurring water
that is salty

ESTUARY

an area of brackish water
where freshwater from a river
mixes with salt water from the
ocean



Activity: Create an ASL Sign

Form groups and create a meaningful and conceptually accurate signs for your assigned terms.

VOLTAGE

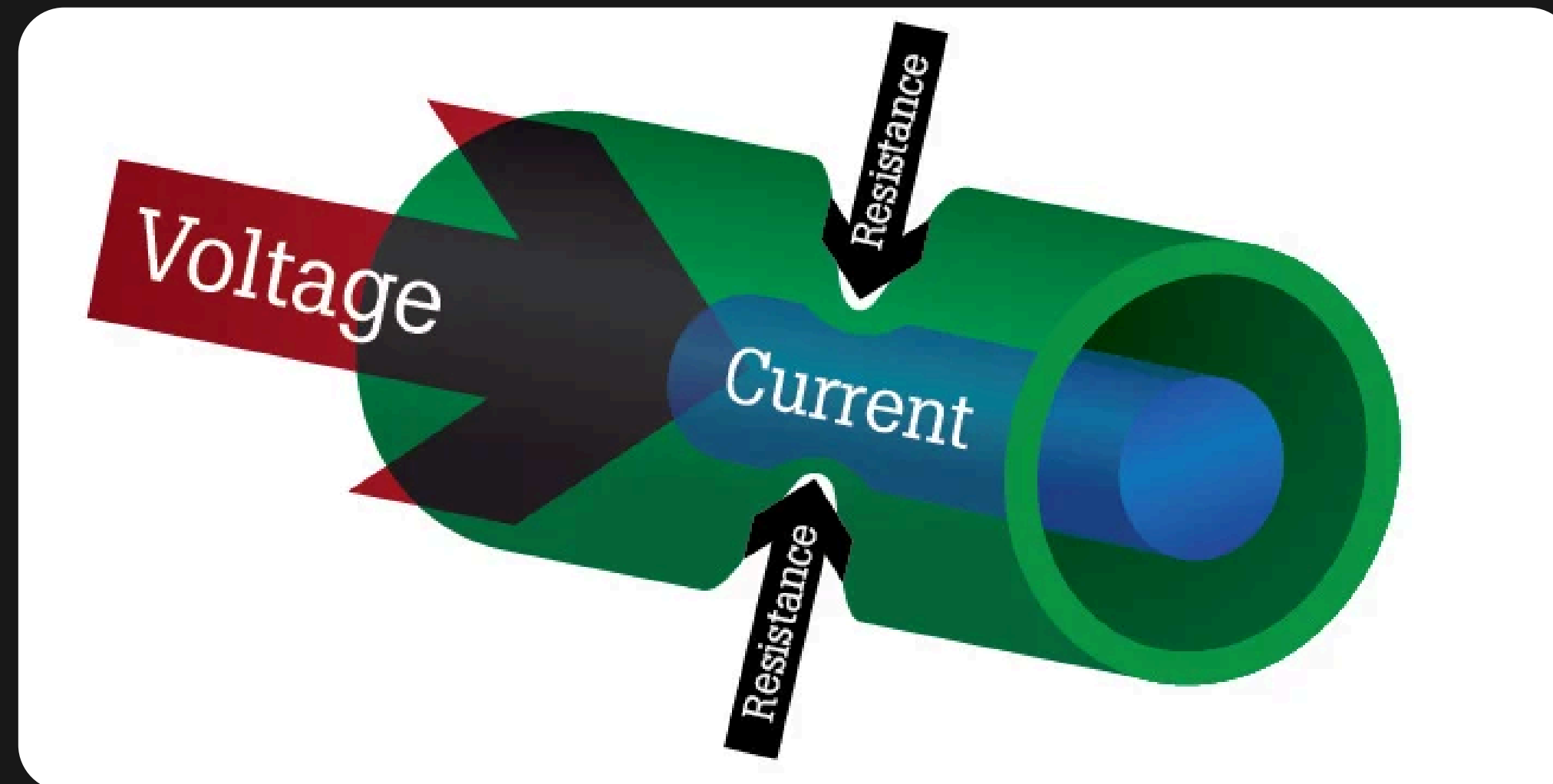
Electrical force that drives the current

CURRENT

A flow of electric charge through a circuit

RESISTANCE

A material's opposition to the flow of electric current



Activity: Create an ASL Sign

Form groups and create a meaningful and conceptually accurate signs for your assigned terms.

CYBERSECURITY

Field focused on protection of computer systems from theft, damage, and unauthorized access



MALWARE

Malicious software intended to harm or exploit any device, service, or network



VIRUS

Type of malware designed to replicate and spread



Activity: Create an ASL Sign

Form groups and create a meaningful and conceptually accurate signs for your assigned terms.



MIND & BODY BREAK

Please be back in 5 minutes

No DST

THE >> SECRET << TO THE MAGIC OF STEM

Three-pronged approach:

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THE >> SECRET << TO THE MAGIC OF STEM

Three-pronged approach:

1. **Vocabulary** -- *Meaningful signs*

2. **Discourse** -- *Engaging and relatable message*

a. Sections of a message

- Introduction
- Body
- Conclusion

b. Engagement

- Metaphors
- Questions
- Analogies

c. Visuospatial uses

- Hierarchy
- Space
- Relationship
- Scale

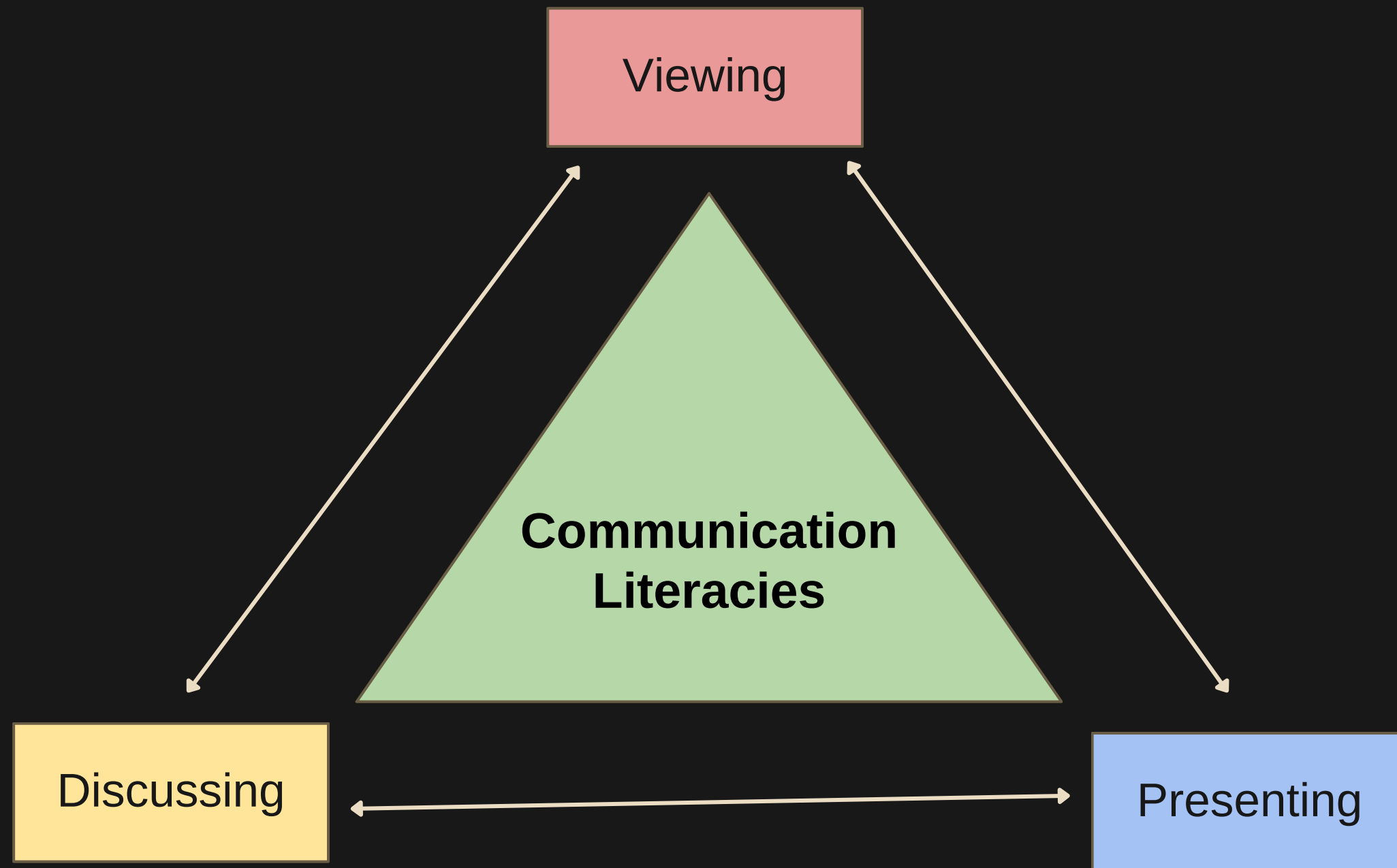




- Different perspectives and knowledge on a given topic
- Language follows background and training

ACADEMIC LANGUAGE STRATEGIES

Using Discipline-Specific Strategies



DISCOURSE: SOCIAL VS ACADEMIC SETTINGS

The way we converse and/or express our ideas differ
between **social** and **academic** settings

sign choices, syntax, spatial constructions, etc.

DISCOURSE: SOCIAL VS ACADEMIC SETTINGS

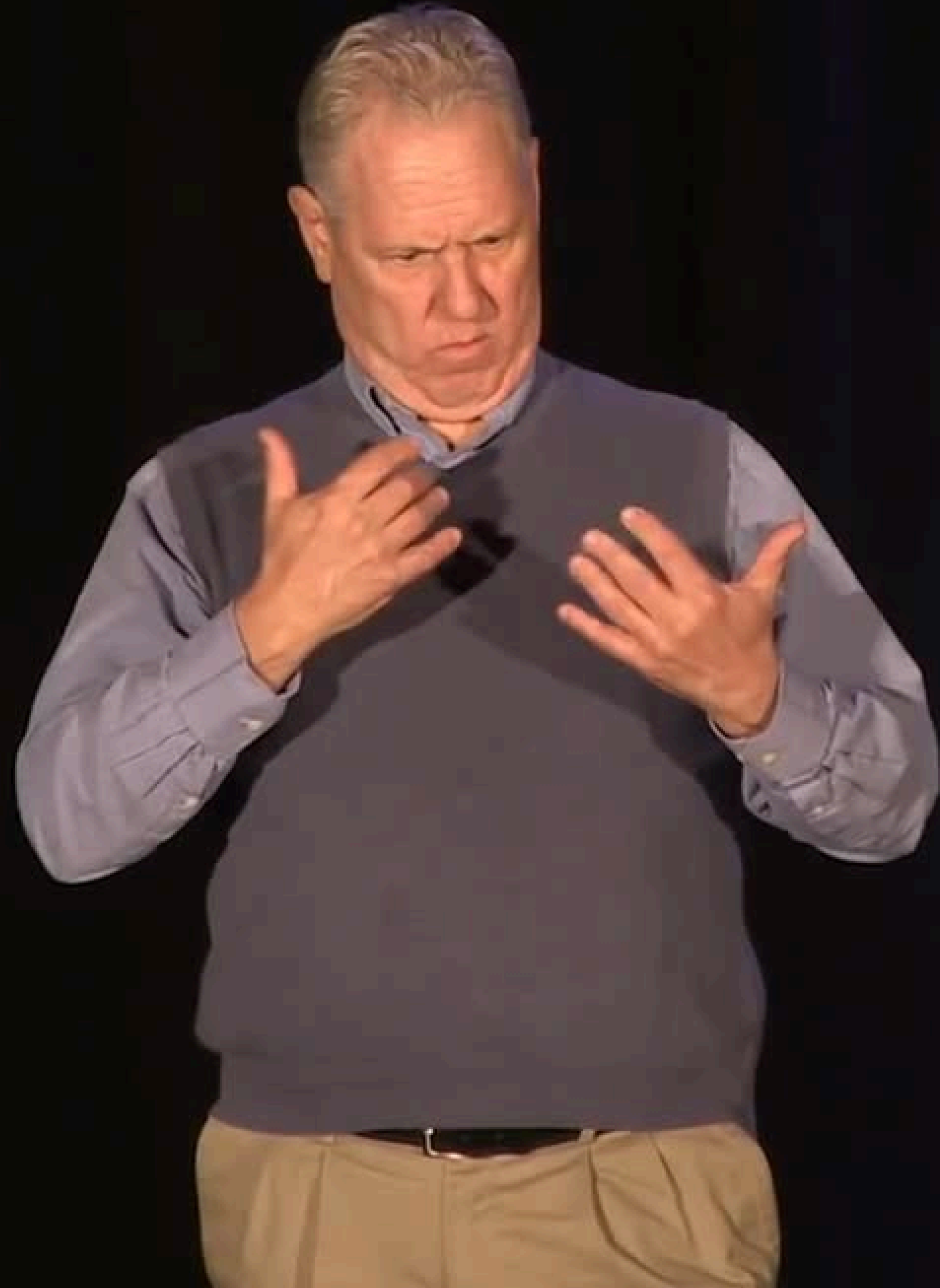
The way we converse and/or express our ideas differ
between **social** and **academic** settings

sign choices, syntax, spatial constructions, etc.

What does discourse look like in STEM?

We do not know

{{ Essentially, an unexplored frontier }}





DISCOURSE: SOCIAL VS ACADEMIC SETTINGS

- Consumer signs versus technical signs

DISCOURSE: SOCIAL VS ACADEMIC SETTINGS

- Consumer signs versus technical signs
- Social syntax versus academic syntax
 - *Which language do you feel is easier to understand in STEM (English or ASL)?*
 - **ASL** → **more visuospatial** and ability to use **OSV** (“topic first” structure)
 - STEM topics have a lot of **details**, **nuances**, and **exceptions**
 - Therefore, **establishing the situation** becomes more important in orienting one’s mind to the topic at hand before coloring the situation with details

THE >> SECRET << TO THE MAGIC OF STEM

Three-pronged approach:

1. Vocabulary -- *Meaningful signs*
2. **Discourse** -- *Engaging and relatable message*
3. Knowledge -- *Understanding of the topic*



Vocabulary

Vocabulary

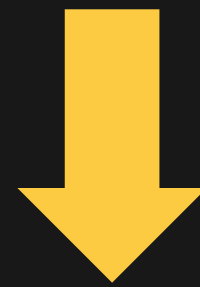


Syntax

Vocabulary



Syntax

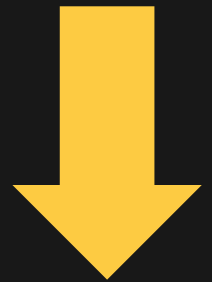


Delivery

Vocabulary



Syntax



Delivery



DISCOURSE

HOW DO YOU PROCESS SCIENCE INFORMATION?

When you are reading the science text or hearing the information in English...

What goes on in your head?

Visualize

Understand



Express



Visualize

Understand

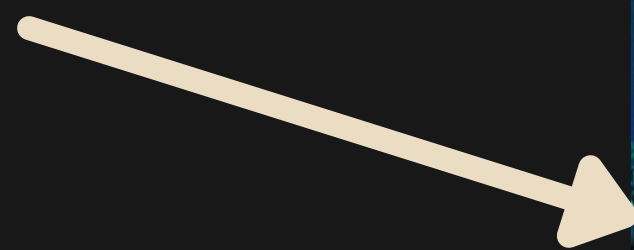
Express



Goal: After receiving information, create a language free environment before expressing it

LANGUAGE

1



LANGUAGE

2



BREAKOUT GROUPS

Language play time!

LANGUAGE PLAY: ENGLISH → ASL

Fossils are remains or traces of plants and animals
that lived a long time ago.

LANGUAGE PLAY: ENGLISH → ASL

Fossils are remains or traces of plants and animals that lived a long time ago.

- Ordering of information (usually, establish time first)
- Circularity (repetition is useful!)
- Quality of signs (ability to modify)

LANGUAGE PLAY: ENGLISH → ASL

During nighttime is when the sun is shining on
the other side of the earth.

LANGUAGE PLAY: ENGLISH → ASL

During nighttime is when the sun is shining on
the other side of the earth.

- Ordering of information (ranking of importance)
- Point of reference (earth)

LANGUAGE PLAY: ENGLISH → ASL

Plants produce its own energy from the sun and nutrients. When a rabbit consumes plants, it gets a fraction of the energy generated by the plants.

LANGUAGE PLAY: ENGLISH → ASL

Plants produce its own energy from the sun and nutrients. When a rabbit consumes plants, it gets a fraction of the energy generated by the plants.

- Point of reference (plants)
- Spatial usage
- Quality of signs (ability to modify)

LANGUAGE PLAY: ENGLISH → ASL

Over the last century, the burning of fossil fuels like coal and oil has increased the concentration of carbon dioxide in the atmosphere and raised the global temperatures.

LANGUAGE PLAY: ENGLISH → ASL

Over the last century, the burning of fossil fuels like coal and oil has increased the concentration of carbon dioxide in the atmosphere and raised the global temperatures.

- Numbers: quantity vs label (CO₂)

“Playing the Numbers Game”

QUANTITY

vs

LABEL

2 cats

V4 engine

“Playing the Numbers Game”

What about chemical equations?



“Playing the Numbers Game”

What about chemical equations?



Chemical equations contain both **quantity** and **label**



LANGUAGE PLAY: ENGLISH → ASL

The sun does not rotate around us,
instead the earth rotates around the sun.

LANGUAGE PLAY: ENGLISH → ASL

The pH scale ranges from 0 – 14. Less than 7 is acidic and greater than 7 is basic. Freshwater typically has a pH of 6.0, ocean saltwater a pH of 8.0, and estuary water a pH of 6.5 – 8.5.

LANGUAGE PLAY: ENGLISH → ASL

An immune cell is old and is no longer functional.
It received chemical signals from nearby cells
to undergo cellular suicide.

LANGUAGE PLAY: ENGLISH → ASL

A 20-lb dumbbell is heavier than
a baby sea turtle.

LANGUAGE PLAY: ENGLISH → ASL

Plants react to drought by sending their roots
into the ground to search for water

MIND & BODY BREAK

Please be back in 5 minutes

No DST

ASL IS HIGHLY VISUOSPATIAL

We should play to its strengths

ASL is a

living and breathing entity

as long there are

people **using** the language

ASL is a
living and breathing entity
as long there are
people **using** the language

ASL feeds us and we feed ASL

What can **ASL** do for **us** and
what can **we** do for **ASL**?

THE >> SECRET << TO THE MAGIC OF STEM

Three-pronged approach:

1. **Vocabulary** -- *Meaningful signs*
2. **Discourse** -- *Engaging and relatable message*
3. **Knowledge** -- *Understanding of the topic*



WHY ARE WE HERE? WHY DO WE DO THIS?



- We want to **ASLize** STEM!!
 - Halt the cycle of English colonization; take ownership of our language, ASL
 - Foster wonder and curiosity about STEM
 - Show that anyone can understand and enjoy STEM
 - Empower deaf people to create signs and critically evaluate them
 - Expand more STEM content in ASL
 - We want and will post them!

WHAT CAN YOU DO?

- Start conversations with your colleagues
- Critically and constantly evaluate how you deliver STEM information
- Empower deaf people to take ownership of their language and enrich ASL through **visualization** and **creative language play**



SUMMARY

- **Language builds language**
 - Solid foundation in ASL → solid foundation in English
 - Careful consideration of when to use fingerspelling and initialized signs
- **Vocabulary knowledge is a network of connected concepts**
 - How signs are related to **each other**
 - How signs change **across topics**
 - How the **shade of meaning** change among signs
 - How signs can be broken down into **elements**
- STEM sign development is a collaborative effort with **deaf people taking the lead**

SUMMARY

Three-pronged approach:

1. **Vocabulary** -- Meaningful signs
 2. **Discourse** -- Engaging and relatable message
 3. **Knowledge** -- Understanding of the topic
- Visualization technique will help you break free from the English structure
 - Critically evaluate your work **before**, **during**, and **after** an assignment and how you can empower deaf students/clients
 - Consider how you might place an unintentional burden on them
 - Empower deaf people to become **authors** of their language
 - STEM signs are novel and we are undergoing a transition period

STEM SIGN REVIEW

- Atomic Hands
- STEM
- Upwelling
- Variable
- Density

- Molecule
- Ionic Bond
- Covalent Bond

- Energy
- Kinetic Energy
- Potential Energy

- Energy
- Food Chain
- Autotroph
- 1st/2nd/3rd Consumer

- Fossil
- Fossil fuels
- Atmosphere
- Carbon Dioxide
- Oxygen
- Coal
- Oil

- State
- Matter
- Solid
- Liquid
- Gas
- Melting
- Freezing
- Evaporation
- Condensation
- Sublimation
- Deposition

STEM SIGN REVIEW

- Gene
- Mutation
- Single Base Substitution
- Estuary
- Fresh Water
- Salt Water
- Perimeter
- Area
- Circumference
- Voltage
- Current
- Resistance
- pH
- Acid
- Base
- Immune
- Apoptosis
- Equation
- Expression
- Equilateral Triangle
- Isoceles Triangle
- Scalene Triangle

QUESTIONS / THOUGHTS



THANK YOU

for the honor of working with you!

BRINGING STEM ALIVE

in American
Sign Language
(ASL)



ATOMIC HANDS

ASL STEM Storybooks



ASL STEM Videos



ASL STEM Dictionaries

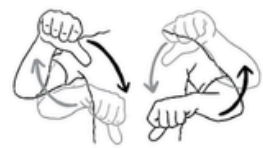


ASL STEM Resources



NEW

tachyo



Science



Technology



Engineering



Mathematics



Education

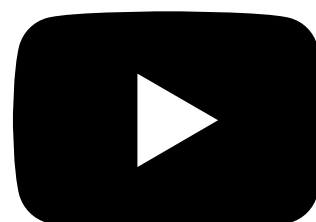
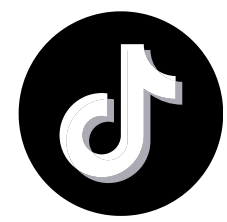
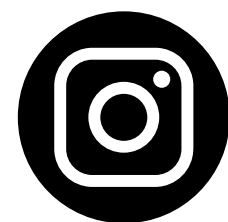
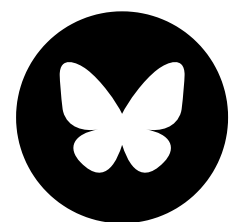
ASL STEM Shop



Deaf STEMist Network



www.atomichands.com



Interpreter Giving Circle

