IDEA-STEM

Inclusive Teaching Practices in Science Education

STEM and Disability Virtual Symposium

February 22-25, 2021

About Me

IDEA-STEM

- Director of Research and Chief Inclusion and Accessibility Officer, CNIB
- Assistant Professor (Adjunct), Faculty of Health Sciences, Queens University and Faculty of Business and Information Technology, OnTechU
- Co-founder, IDEA-STEM
- Researcher in social determinants of health and social outcomes
- Cancer geneticist; genomics and experimental therapeutics

What do Students with Disabilities Study?

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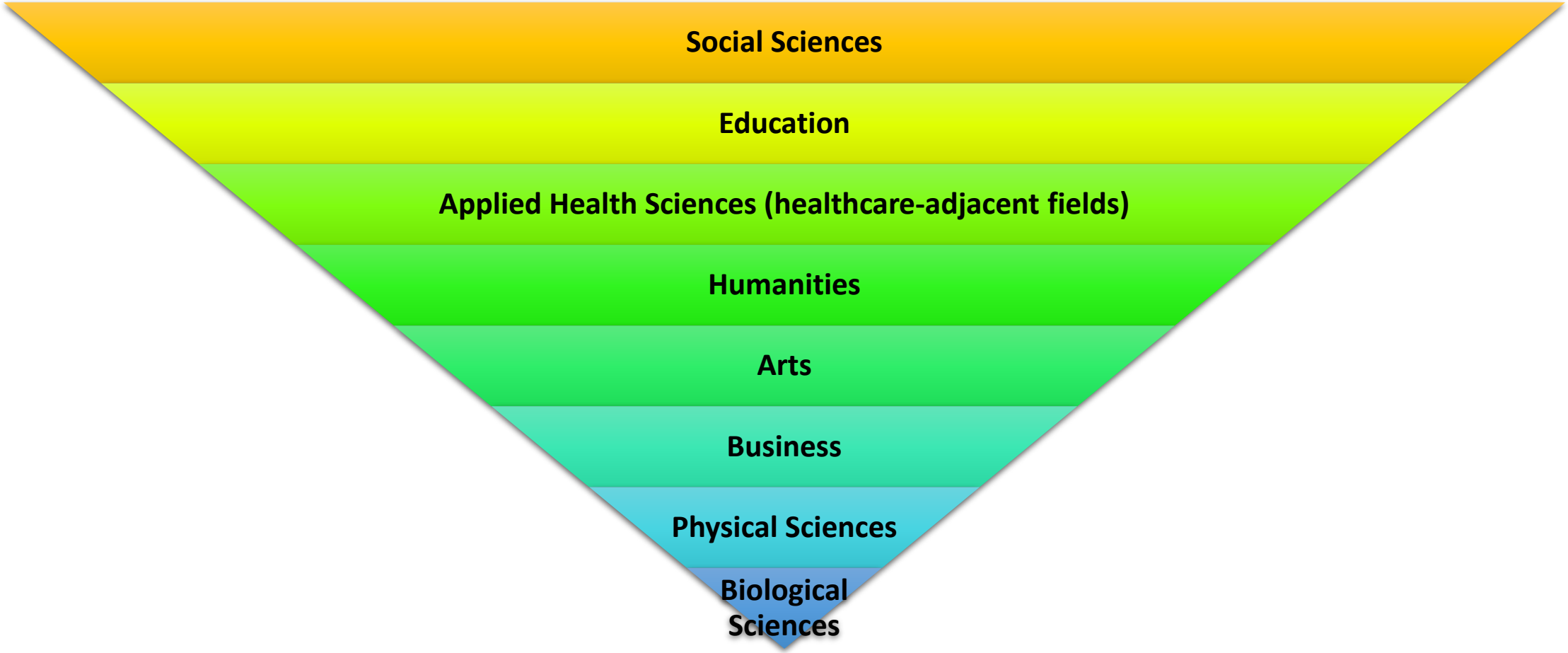

The STEM Profession Training Pipeline

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Glass Ceilings in The Pipeline

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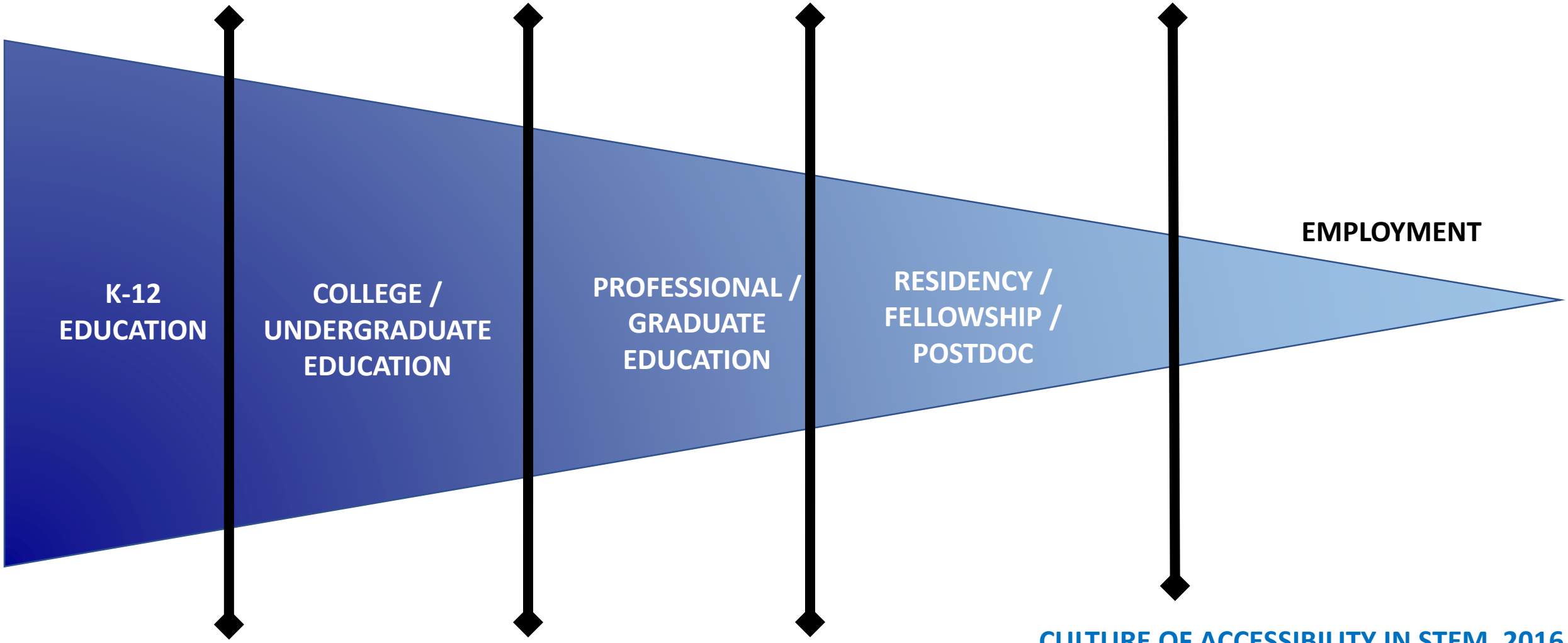

CULTURE OF ACCESSIBILITY IN STEM, 2016

Solutions to Underrepresentation

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1. **Filling the Pipeline** – increasing the number of trainees with disabilities entering the pipeline

2. **Breaking the Glass** – increasing the number of trainees with disabilities moving from one stage to the next in the pipeline

3. **Fostering Inclusion** – enabling full participation of trainees with disabilities at every stage of the pipeline

What Barriers do Students Face?

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- Attitudes
- Role models
- Accessible labs
- **Accessible format educational materials**
- Accessible teaching

Attitudes (1)

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Of educators and parents

- Gatekeeping
- “You don’t have the ability to do science”
- “You don’t need to learn science”
- “You don’t need to do this lab experiment”
- “Why are you here?”

Attitudes (2)

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Of students

- Trailblazing
- “I don’t have the ability to do science”
- “I don’t have to learn science”
- “I can’t do this lab experiment”
- “Why am I here?”

Implicit Bias, Diversity and Disability

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- Explicit attitudes ("what we say") vs. implicit attitudes/biases ("what we believe")
- Literature suggests moderate to strong negative attitudes are prevalent within the general population
  - Do we, as educators, have implicit biases that we are projecting on to our students?
  - Knowledge gaps as they may relate to implicit biases
- Implicit Association Tests on Disability and Mental Health
  - https://implicit.harvard.edu/implicit/

Attitudes (3)

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Of educators and parents

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Of students

- Trailblazing
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A Note on Language

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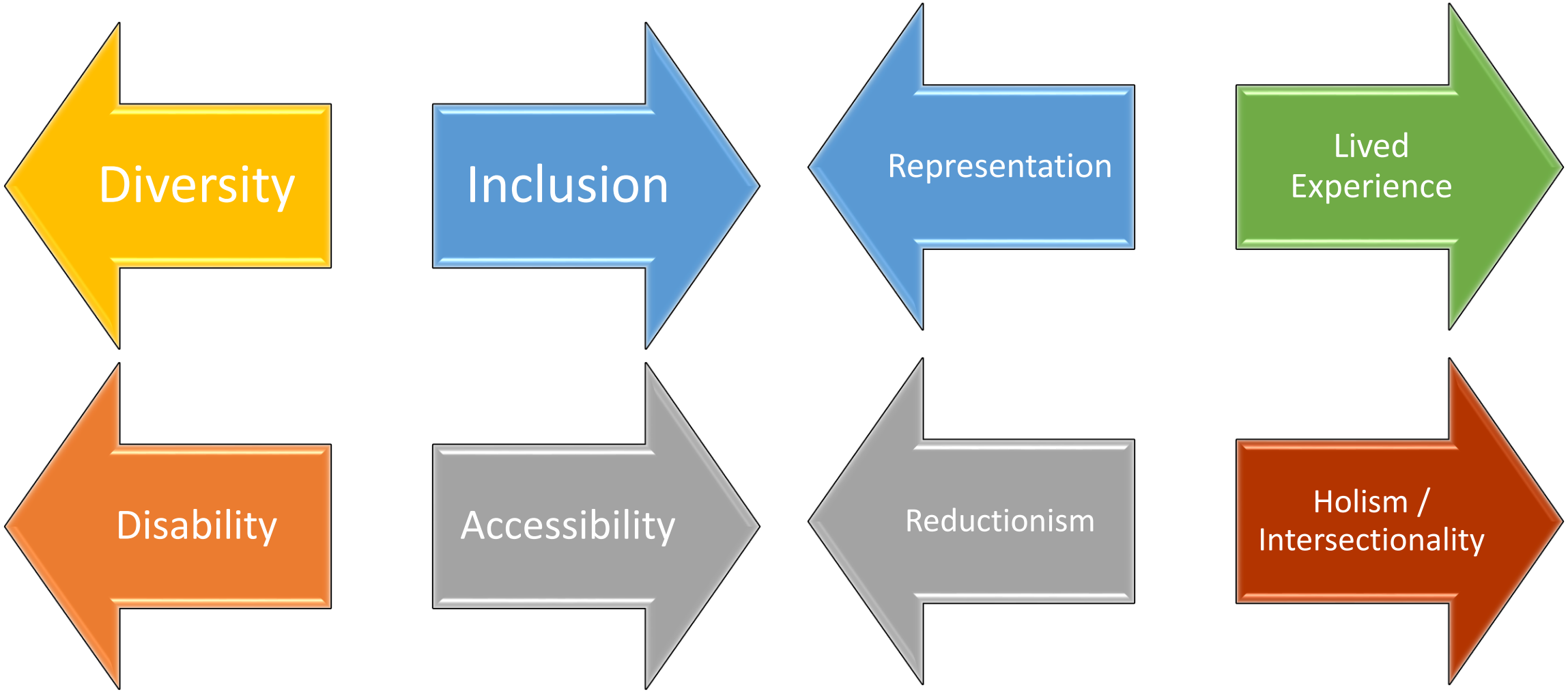

The “Gatekeeper Function” (1)

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- The “**gatekeeper function**” arises from the attitude on the part of an educator that the student ultimately is incapable, or is not fit, to carry out the essential functions of jobs in the student’s chosen field in the sciences.
  - Exclude students with disabilities from studying the sciences
  - “Trade” science courses for other curriculum content or life skills training in the best interests of the student

Rethinking "Ability"

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- Disability is nothing more – and nothing less – than differences in the ways we…
  - …Take in or interact with information
  - …Process information
  - …Communicate information

The “Gatekeeper Function” (2)

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- Often, this belief in lack of fitness, although grounded in an understanding of the discipline, is not grounded in an equivalent understanding of disability, accessibility and accommodation

- Alternatively, on the part of accommodation specialists, the “Gatekeeper Function” may arise from an understanding of disability, but a lack of awareness of how accessibility and accommodation may be integrated into a person’s job or studies

Role Modeling

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- “Someone in science shares something of my experiences”
- “Someone in science looks like me”
- IRL
- Media representation (fiction)

Scientists with Disabilities and their Accomplishments

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Scientist	Field	Expertise/Best Known For	Lived Experience	Time Period
Thomas Fisher	Statistician	Founder of population genetics	Sight loss	Early 20th century
Henry Cavendish	Physicist	Discoverer of Hydrogen	Autism spectrum	Early 19th century
Paul Dirac	Physicist	Quantum theory	Autism spectrum	Early 20th century
Henrietta Leavitt	Astronomer	Stellar evolution	Hearing loss	Early 20th century
Thomas Edison	Inventor	Light bulb (among many other inventions)	Learning disability	Late 19th century
Albert Einstein	Physicist	Relativity theory	Learning disability	Late 19th century
Stephen Hawking	Physicist	Cosmology – physics of simgularities	ALS	Late 20th century/early 21st century
Temple Grandin	Behaviourist	Aminal behavior; autism	Autism spectrum	Late 20th century/early 21st century

Famous (Fictional) Scientists with Disabilities

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STEM Outreach Agencies and Role Modeling

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- Inclusion of, or emphasis on, scientists with disabilities(and other lived experiences) in mentorship and role modeling networks

- International efforts are better – greater likelihood of "critical mass"

- Examples
  - Let's Talk Science career profiling database (new)
  - **SciAccess**

Accessibility in the Science Classroom

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- Teaching
- Labs
- Educational Materials

Why a Focus on Teaching?

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- "Frame of reference" problem for the student
- Explaining visual concepts in nonvisual ways
- Teaching to learning strengths
- Applying Universal Design for Learning
  - Multiple means of representation, expression and engagement

STEM-Specific Challenges

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- Technology over pedagogy
- Representation of visual concepts
- Discipline-specific symbology
  - “An equation is an equation is an equation” … NOT
- Default modes of teaching in STEM
  - “Teaching” vs “Presentation”
  - Student engagement / participation

Technology over Pedagogy

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- The Doppler Effect
- Flight
- Dissection

Nonvisual Representation of Visual Concepts

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- Visual and spatial representations of relationships
  - Data ➔ charts and graphs
  - Illustrations / artwork
  - Pictures
  - Diagrams

- **Tactile (e.g., 3D printing) models in the classroom**

- **Translating visual concepts into sound and touch**

Accessible Labs

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- Accommodations for students with disabilities in the lab setting:
  - **Human technical assistance**
  - Assistive technologies
  - Mainstream technologies
  - **Robotics**
  - **Simulations**

Frameworks for Inclusive Teaching

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- Essential Requirements
- Universal Design for Learning
- Differentiated Instruction
  - Responds to learning gaps as they arise, reactive approach
  - Differentiate: content, process, environment, assessment
- Individualized Accommodations

What is an ”Essential Requirement?”

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- "**Essential requirements** of a course or program refer to the knowledge and skills that must be acquired or demonstrated in order for a student to successfully meet the learning objectives of that course or program" (Rose, 2009).

Essential Requirements

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- Defined by two factors:
  - Skills that must be necessarily demonstrated in order to meet the objectives of a course
  - Skills that must be demonstrated in a prescribed manner

- It is extremely important to not confound the evaluation method with the actual competency.

- For example, if a student must understand how to design, interpret, analyze and troubleshoot a scientific experiment (“competency”), does this mean that the student must perform the experiment unaided (“measurement”)?

Questions for Consideration

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- What is being tested?
- What is the nature of the task?
- Does it have to be done in only one way?
  - If so, why?
- Will performing this task in an alternative manner ultimately interfere with the student's successful performance in the discipline, program or course?

The "Hidden Curriculum"

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- All the things we **want** and **expect** students to know (or learn) without formally…
  - …Teaching them
  - …Calling these skillsets out (orally or in writing)

- Often drivers of success in the field

- Transition issue – students "don't know what they don't know" and "don't know what they're not aware they need to know"

What is Universal Design?

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- Universal Design (UD) is geared towards creating barrier-free environments for everyone and consequently, is often promoted as a panacea (“cure-all”) to the challenges of individualized accommodation.

- UD is intended to ensure that products and environments are “usable by all people, to the greatest extent possible, without the need for adaptation or specialized design” (The Center for Universal Design, 1997).

Models of Universal Design (UD)

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- The Physical UD Model ➔ Universal Instructional Design (UID) ➔ Equity and equality of USE
- The UD for Learning Model ➔ Equity and equality of ENGAGEMENT with information
- The UD for Social Inclusion Model ➔ Equity and equality of PERSONAL INTERACTION

Dimensions of Accessibility and Inclusion in STEM

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- Technology, platform and format of materials ➔ **Physical UD**
- Course development and creation ➔ **UD in Learning (UDL)**
- Instructor/student interaction ➔ **Cultural UD**
- Assessment ➔ **Differentiated Instruction (DI)**

Differentiated Instruction

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- Differentiated instruction: Data gathering in the course of teaching as a way to inform, modify instruction as a course progresses
- Instructor can differentiate the materials, process, assessments, environment
- Does NOT involve changing the curriculum expectations
  - If there is a general curriculum expectation, however, topics can be diversified to match student interests and frames of reference

Data Gathering

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- Every learner is different
  - Different learning modes
  - Different backgrounds
  - Different experiences
  - Different frames of reference for course content

- Data gathering facilitates a deeper understanding of learners and their prior experiences, leading to a better learning environment for all

Data Gathering in Differentiated Instruction → Assessment

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- Assessment *for* learning
- Assessments *as* learning
- Assessments *of* learning
- Formative vs summative assessment

- SPECIFIC and TIMELY FEEDBACK to students

- In the online learning context, this is more difficult…
  - …But not impossible!

Types of Assessment

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- More than just quizzes/tests!

- Inclusive of…
  - Reflective exercises
  - Lived experience activities/journals
  - Group work
  - Presentations/webinars
  - Portfolios
  - Research papers
  - Limited only by imagination

Inclusive Teaching Practices

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- Inclusion as a process to respond to diversity
- Makes “hidden curriculum” explicit
- Uses defined essential requirements
- Use of Differentiated instruction: Data gathering in the course of teaching as a way to inform, modify instruction for groups of students *as a course progresses*
- Full participation: quality of the student experience

Our Foundational Metaphor

In the first image, it is assumed that everyone will benefit from the same supports. They are being treated equally.

In the second image, individuals are given different supports to make it possible for them to have equal access to the game. They are being treated equitably.

In the third image, all three can see the game without any supports or accommodations because the cause of the inequity was addressed. The systemic barrier has been removed.

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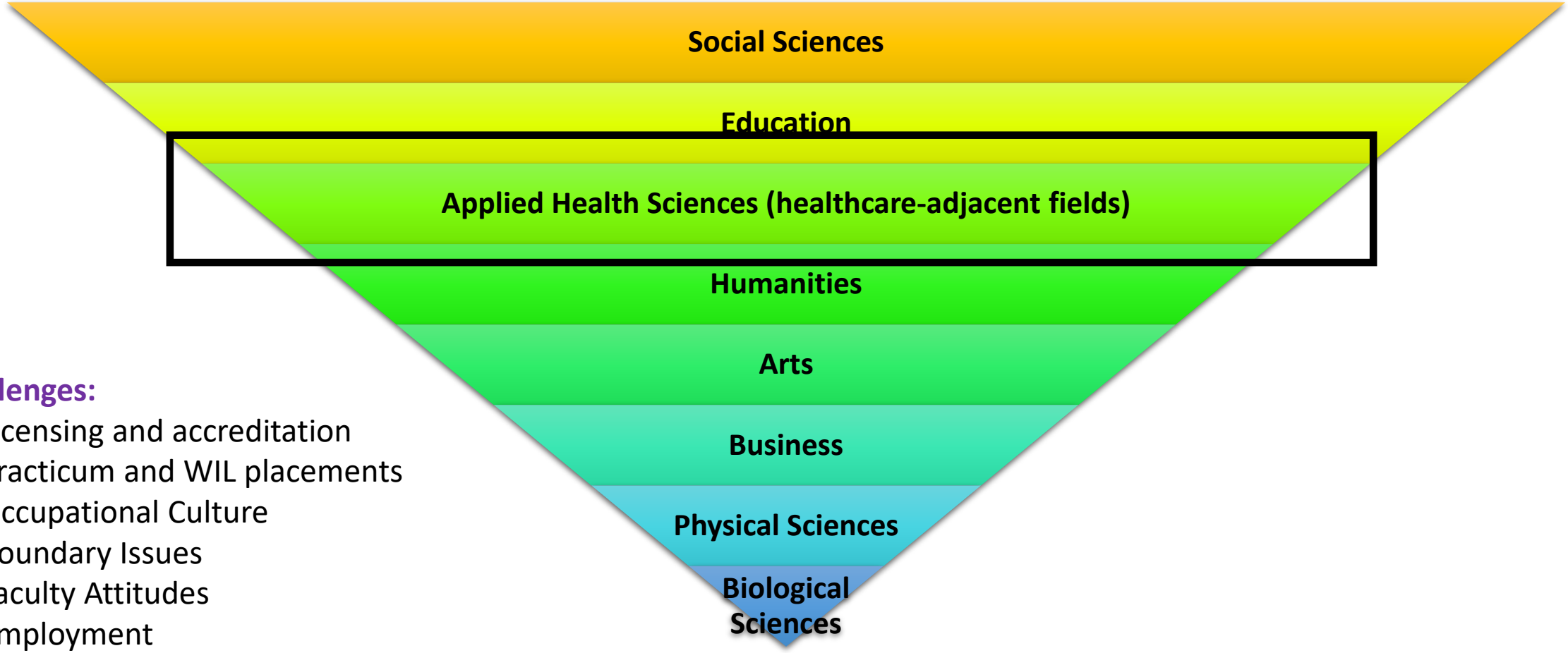

Challenges:

- Licensing and accreditation
- Practicum and WIL placements
- Occupational Culture
- Boundary Issues
- Faculty Attitudes
- Employment

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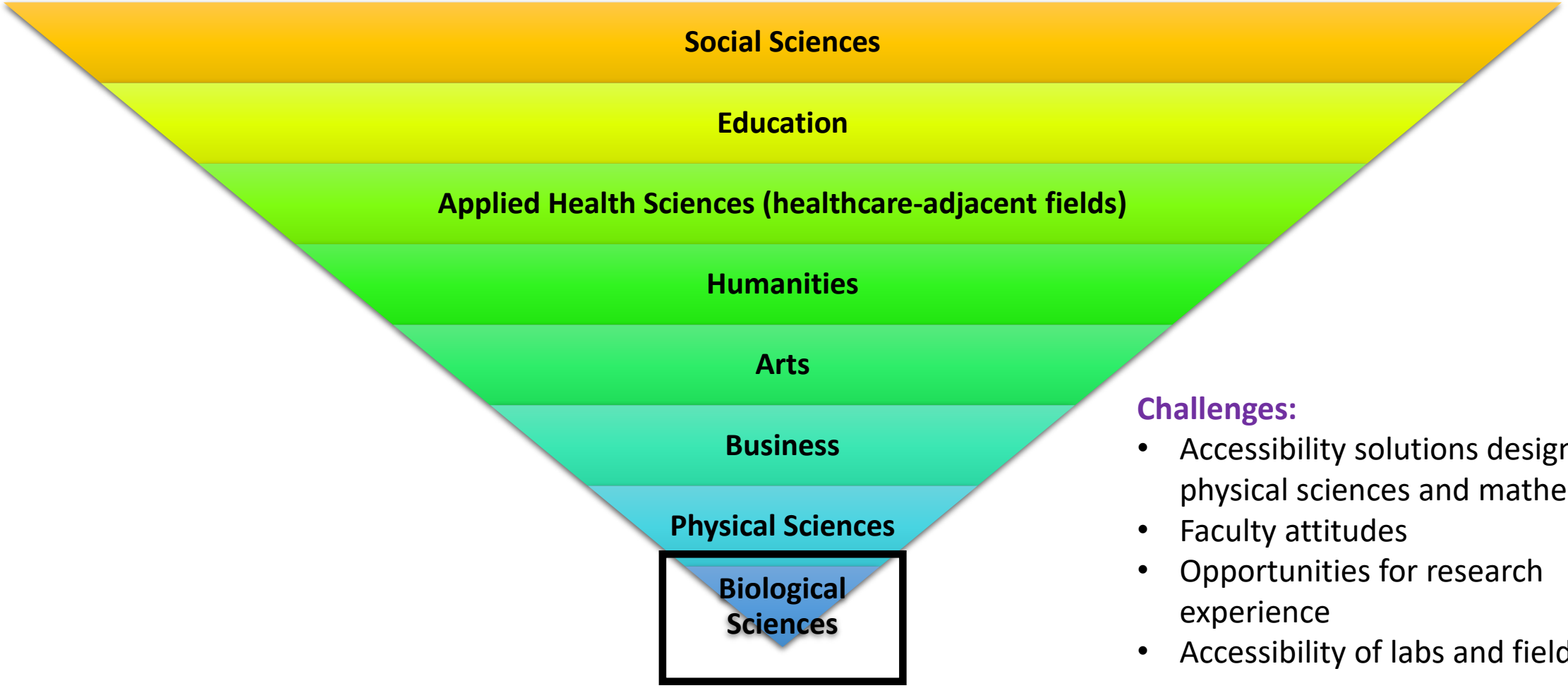

Challenges:

- Accessibility solutions designed for physical sciences and mathematics
- Faculty attitudes
- Opportunities for research experience
- Accessibility of labs and fieldwork

Common Solutions

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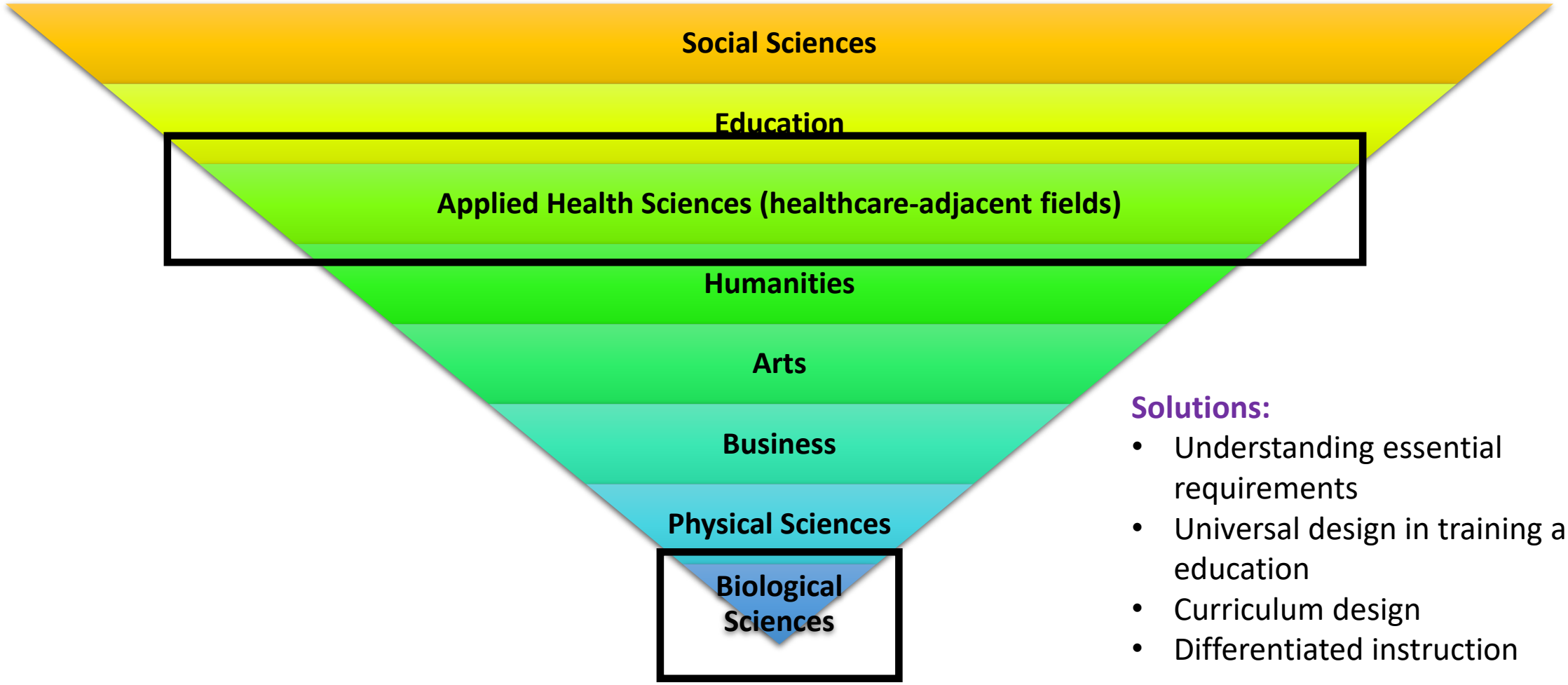

Solutions:

- Understanding essential requirements
- Universal design in training and education
- Curriculum design
- Differentiated instruction

Reference

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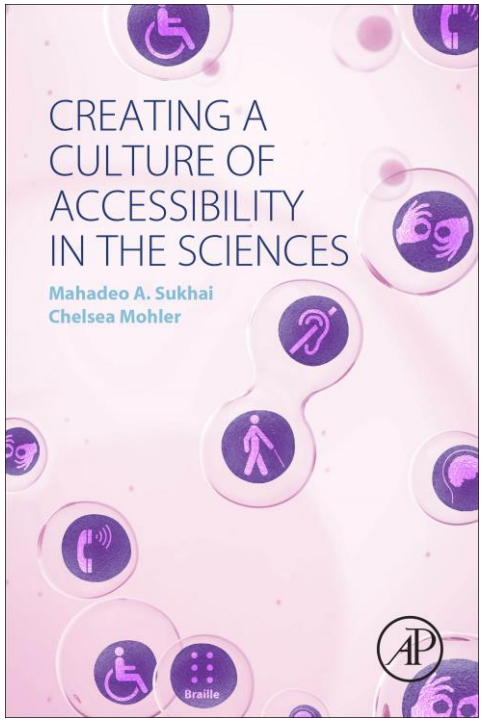

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