

Making Our Science Easier to Understand: Environmental Health Literacy Basics for Researchers

Katie Tomsho

Instructor, Dept. of Environmental Health

Director of Community Outreach, CEC

September 30, 2026



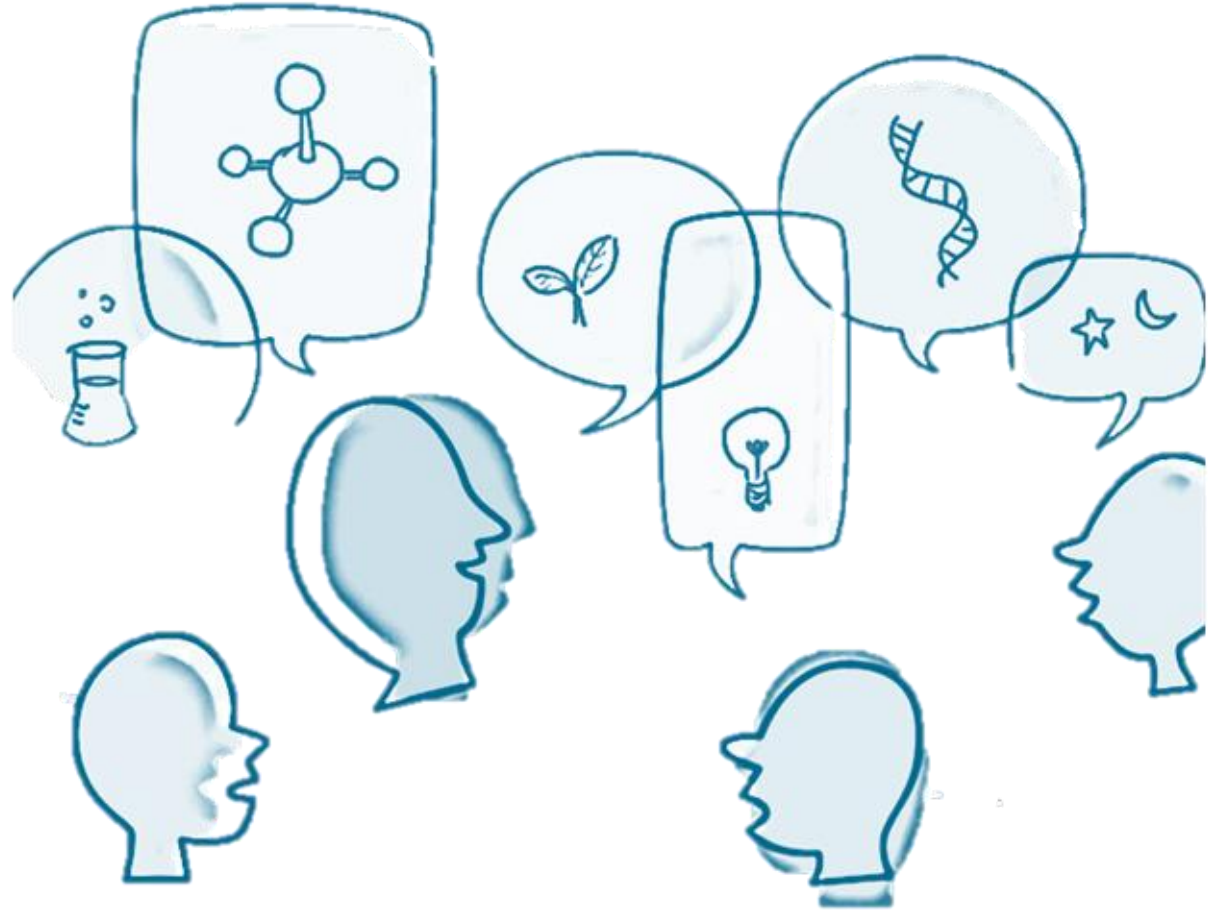
Harvard Chan NIEHS Center
for Environmental Health
Science Communications Hub



“What makes environmental health science accessible (not just available)?”

Outline

1. Report Back of Results & Environmental Health Literacy
2. Communication Models
3. Literacy
4. Numeracy
5. Data Evaluability
6. NIH Policy on Report Back



Today's Workshop Objectives

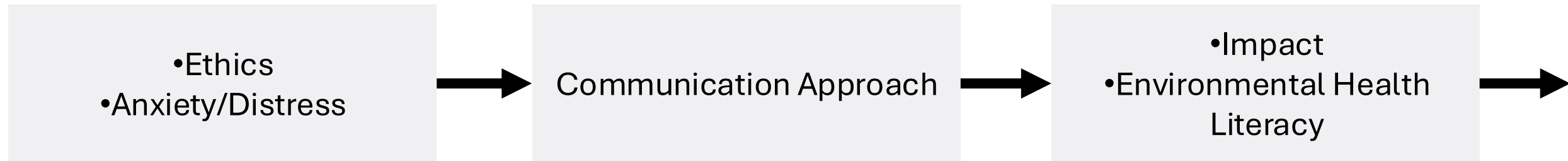
- Upon completion of this workshop, you will be able to:
 1. Describe the basic concepts of literacy, numeracy, and environmental health literacy
 2. Identify factors of communications that pose challenges for audiences with low literacy skills
 3. Apply basic tools to enhance accessibility of written materials



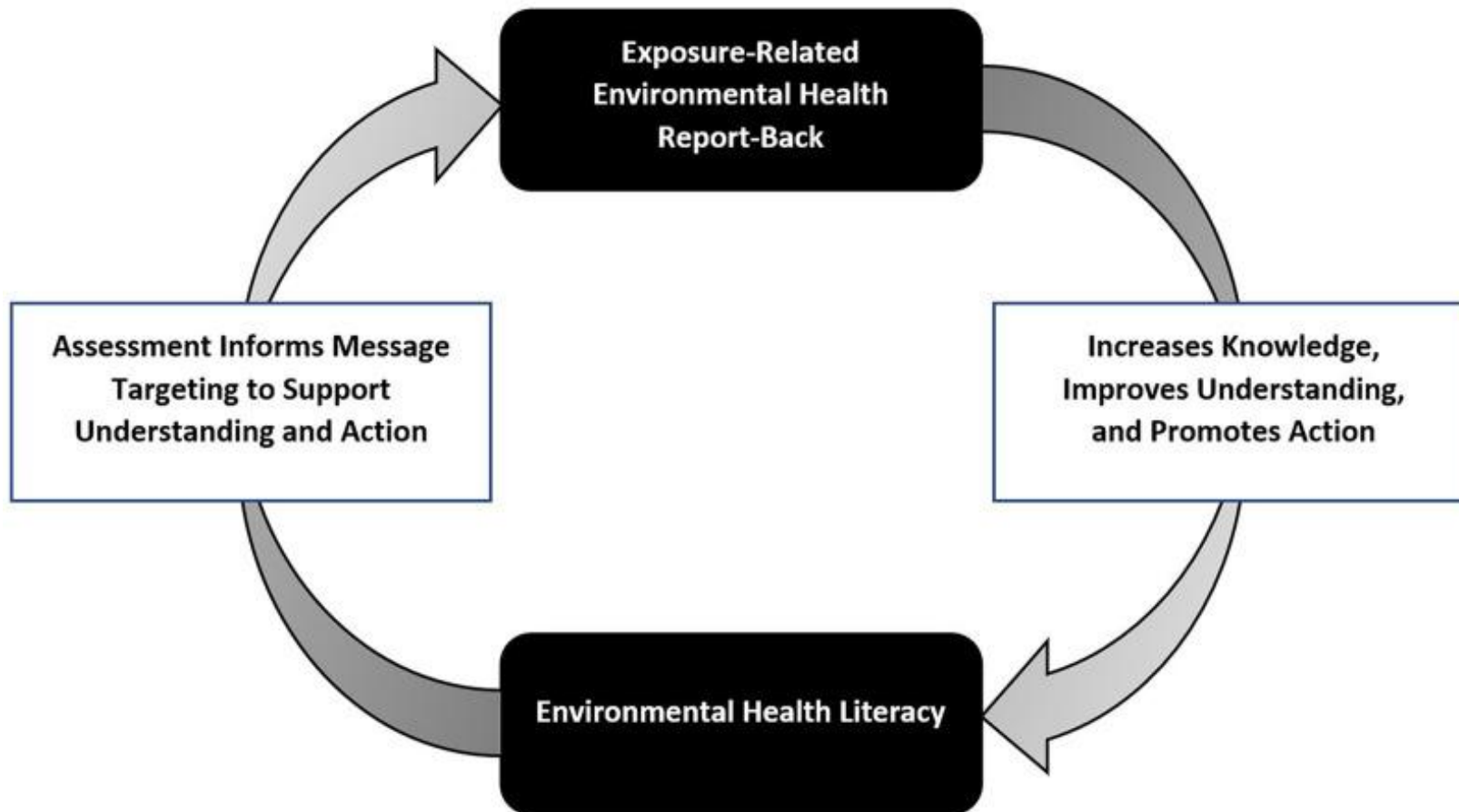
(Image: Collins, 2026)



3 Waves of Environmental Health Data Report-Back Literature

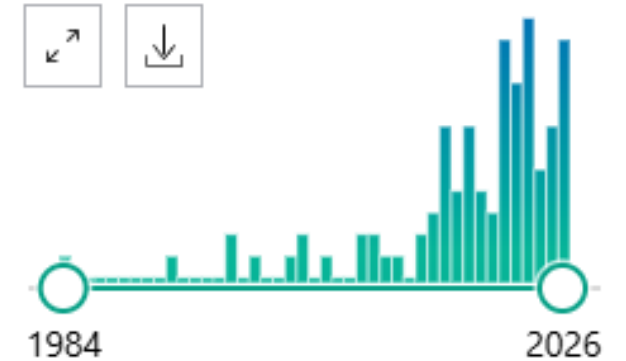


Data Report Back & EHL



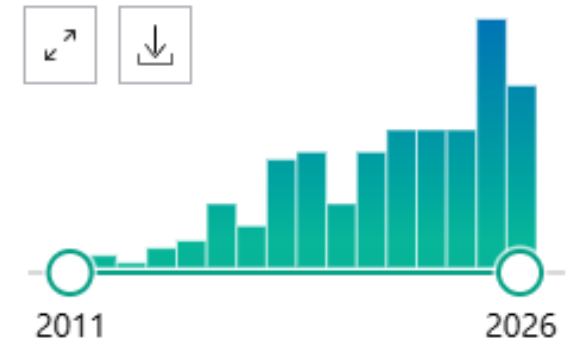
(Figure: Hoover, 2023)

RESULTS BY YEAR



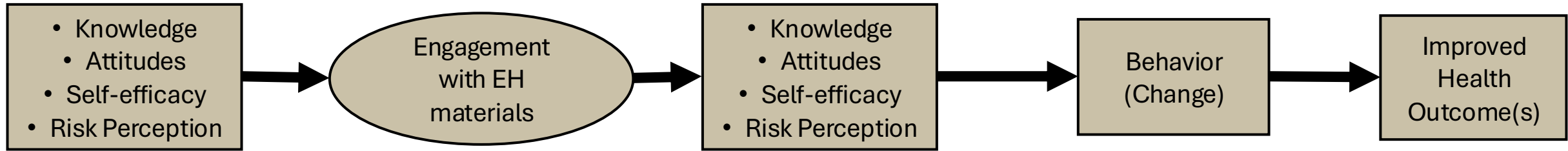
“report-back” AND “environment*”

RESULTS BY YEAR

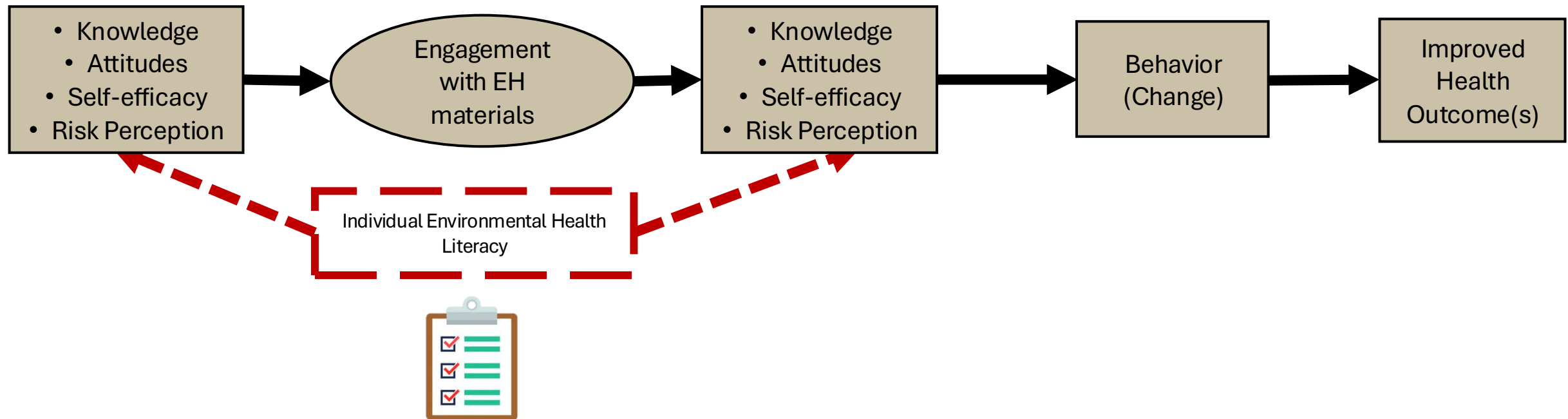


“environmental health literacy”





“What is the Impact of our Message(s)?”



(Icons: Freepik, 2023)



Evolving Definitions of EHL

Society for Public Health Education, 2008

“Environmental health literacy integrates concepts from both environmental literacy and health literacy to develop the wide range of **skills and competencies** that people need in order to seek out, comprehend, evaluate, and use environmental health information to make informed choices, reduce health risks, improve quality of life and protect the environment.”

(Finn & O’Fallon, 2017)



Evolving Definitions of EHL

- “Individuals who are proficient in EHL are able to **recognize their exposures and exert some manner of control** over them rather than feeling as if ‘there’s nothing I can do.’”

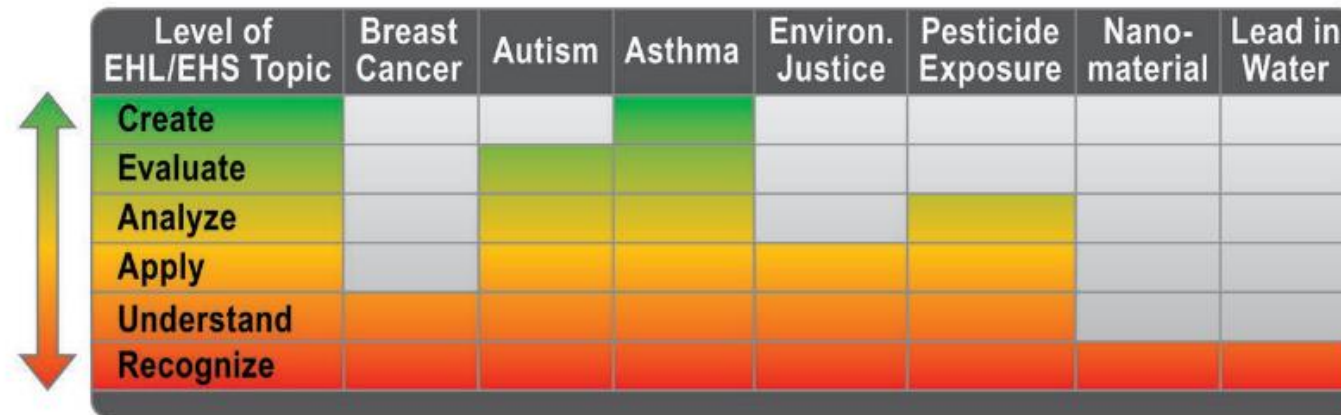


Figure 2. Conceptual model of environmental health literacy adapted from Bloom (1956), representing the potential for different levels of EHL across various environmental health science topics.

(Finn & O’Fallon, 2017)



Evolving Definitions of EHL

- “...environmental health literacy can be defined as an emerging and evolving multidisciplinary field that seeks to better understand how individuals and communities make **sense of and act on** health-related information about environmental hazards. This definition makes clear that EHL requires basic scientific knowledge about contaminants, human health, and exposure pathways; however, such knowledge may not be sufficient for action. Rather, people at more advanced levels of EHL also need to understand the **complicated roles, responsibilities, and uncertainties related to environmental health decision and solution implementation-processes**”

(Hoover, 2019)



Principles of EHL

- Requires knowledge about:
 - Science of environmental contaminants
 - Pathways of exposures
 - How exposures relate to human health
- Requires skills to:
 - Seek and use information
 - Positive perceptions of personal agency to act on that information
- Proposed hierarchy of EHL levels
 - Top-most requires sophisticated understanding of stakeholders, uncertainty, and application of information to reduce exposures

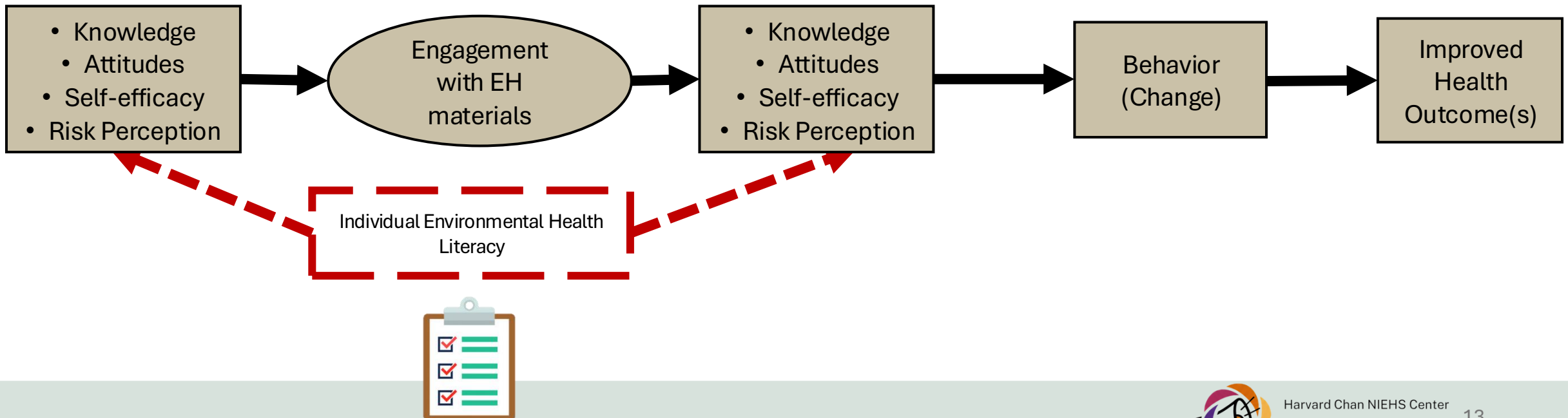


(Image: Shah, 2018)



What has the field (largely) focused on so far?

- Transfer of information
 - Outcomes in EHL: education, knowledge gain
- Impact on health behaviors and actionability
 - Outcomes in EHL: adopting behaviors, intention to act



Individual Capacity

- Prose
- Quantitative
- Document

Complexity and Difficulty of Printed Messages



Engagement with EH materials

- Knowledge
- Attitudes
- Self-efficacy
- Risk Perception

- Knowledge
- Attitudes
- Self-efficacy
- Risk Perception

Behavior (Change)

Improved Health Outcome(s)

Individual Environmental Health Literacy



Environmental Health Literacy



Individual Capacity

- Prose
- Quantitative
- Document

Complexity and Difficulty of Printed Messages



Engagement with EH materials

Environmental Health Data Report-Back

- Knowledge
- Attitudes
- Self-efficacy
- Risk Perception

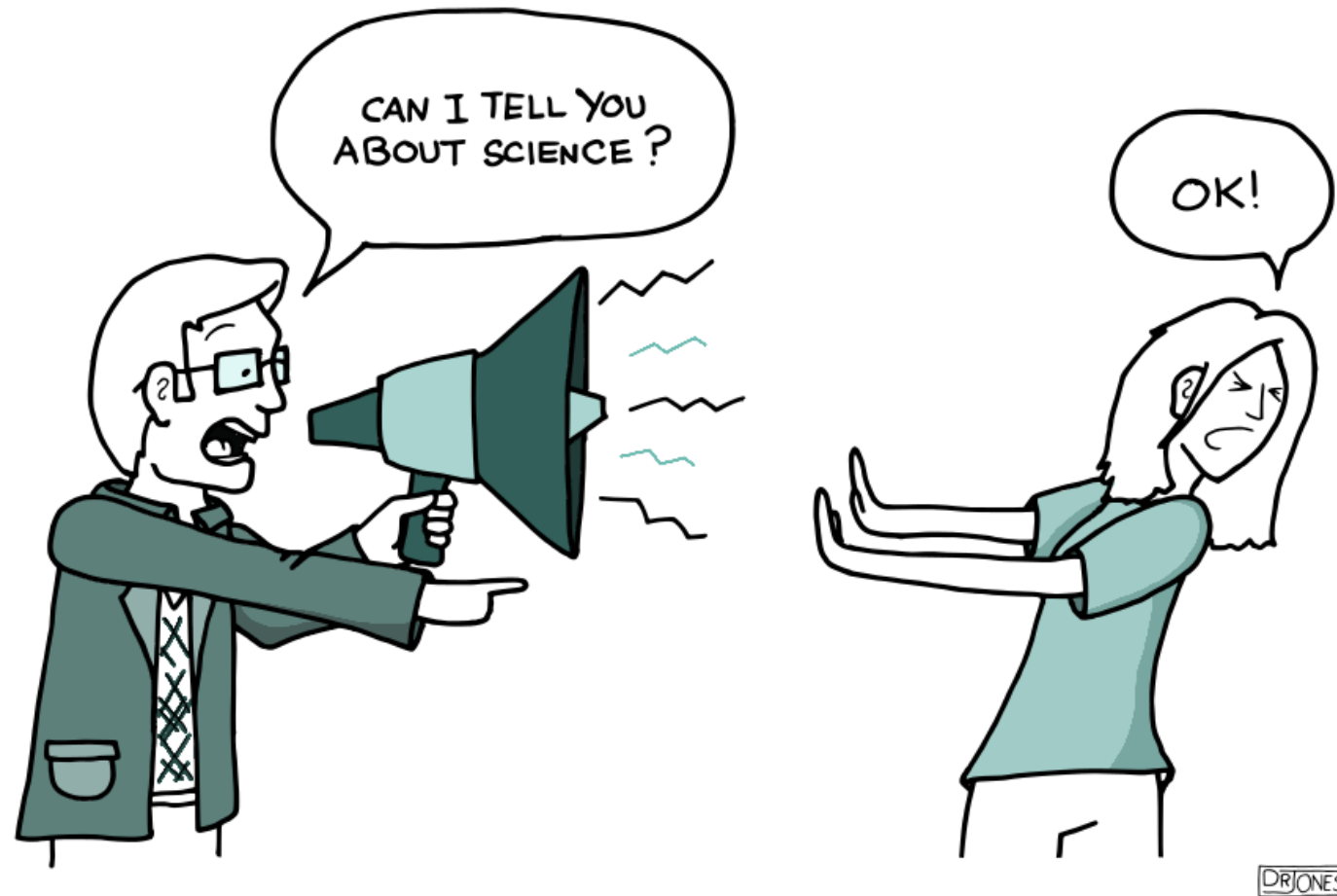
- Knowledge
- Attitudes
- Self-efficacy
- Risk Perception

Behavior (Change)

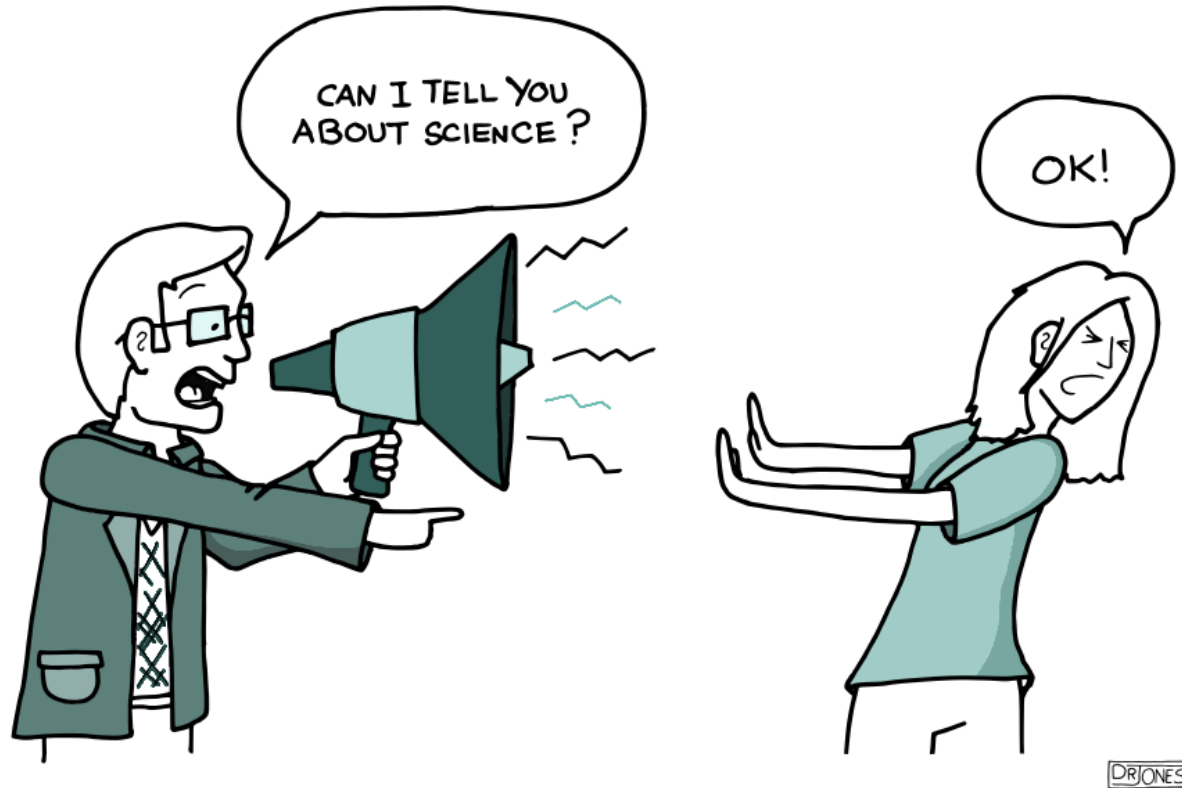
Improved Health Outcome(s)



A Conundrum

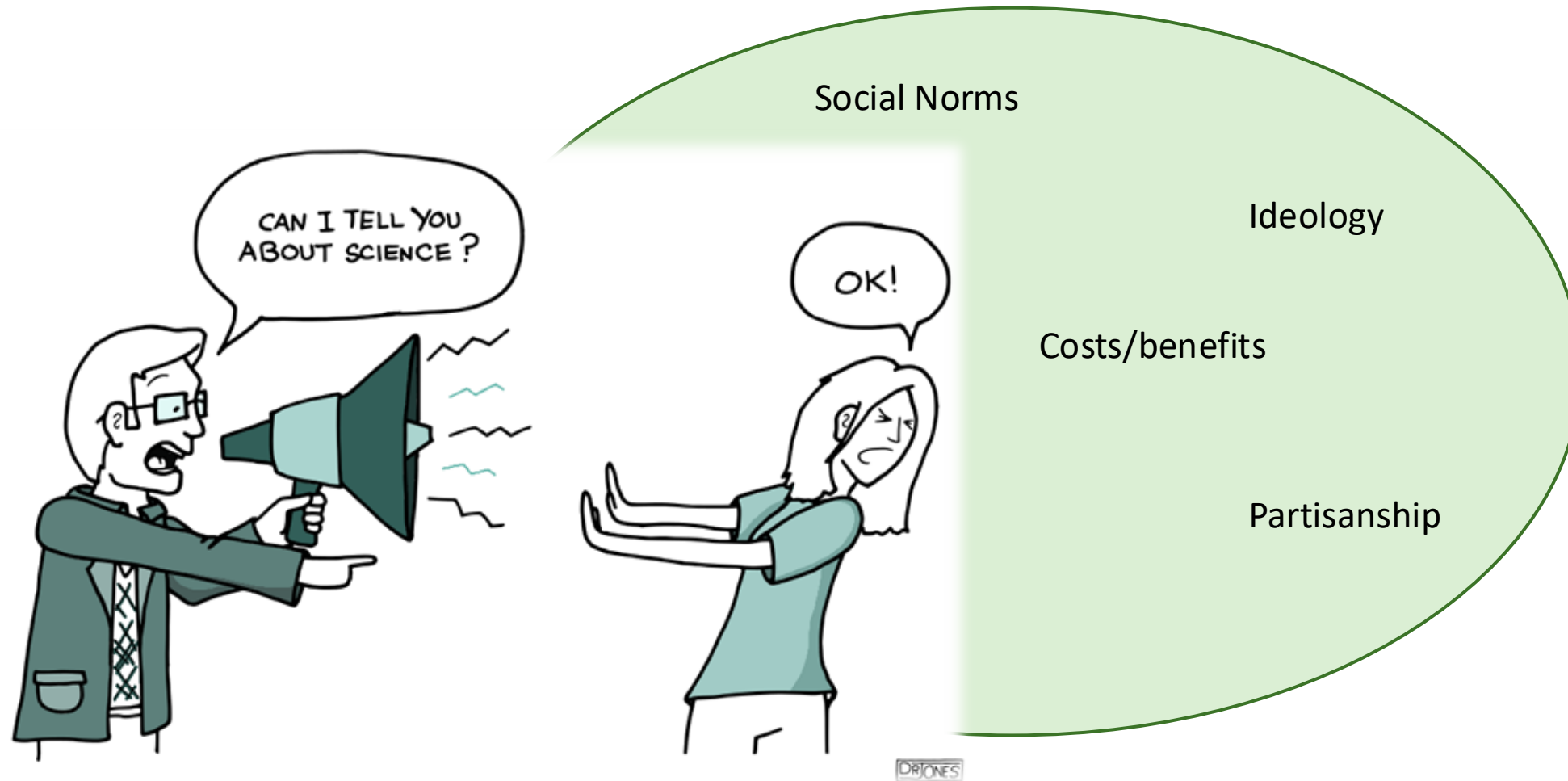


Information Deficit Model



- Public lacks understanding of topic
- Non-acceptance of technical solution attributed to knowledge gap
- Assumption: 'rational actors'
- Solution: increased transfer of information from experts to non-experts

Information Deficit Model



(Nisbet, 2009)



Alternative Perspective

- Building EHL is not (only) about giving people more information
- It is about making information
 - ACCESSIBLE: easy to find, see, hear, navigate
 - APPROACHABLE: clear, relevant, respectful, free of unnecessary jargon
 - INVITING: encouraging questions, engagement, and use of learnings



Alternative Models

	Information Deficit Model	Public Engagement Model	Participatory Model
Information Flow	Unidirectional	Bidirectional	Joint development
Audience Role	Recipient, passive	Consultant/contributor	Equal partner
View of Public	Unaware	Unique perspective	Co-creator of solutions
Barriers to Communication	Ignorance of topic	Trust	Structural exclusion
Goal/Objective	Objective agreement, 'compliance'	Mutual understanding	Shared ownership of solutions/materials
Useful Resources	Grant, W J, 'The Knowledge Deficit Model and Science Communication' (22 Nov. 2023), in Matthew Powers (ed.), <i>Oxford Research Encyclopedia of Communication</i> , https://doi.org/10.1093/acrefore/9780190228613.013.1396	Dickson, D. (2000). Science and Its Public: The Need for a "Third Way." <i>Social Studies of Science</i> , 30(6), 917–923. http://www.jstor.org/stable/285791	Metcalf, J., Gascoigne, T., Medvecky, F., & Nepote, A. C. (2022). Participatory science communication for transformation. <i>JCOM</i> 21(02), E. https://doi.org/10.22323/2.21020501



How Do we Make it Easier to Engage with Environmental Health Science?



(Image: Eliesha, 2025)



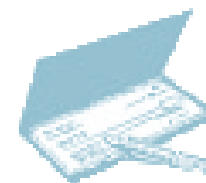
Functional Skills Vary



PROSE



DOCUMENT



QUANTITATIVE

(National Center for Education Statistics, 2006)



Harvard Chan NIEHS Center
for Environmental Health
Science Communications Hub

Tailoring Readability/ Literacy



Program for International Assessment of Adult Competencies (PIACC)

- International study (31-39 countries) of adults 16-65 for literacy, numeracy, and digital problem solving
- Intended to be administered once/decade
 - Cycle 1: 2011-2017
 - Cycle 2: 2023
 - Conducted in the United States in 2011-2012 & 2013-2014, 2023
- All skills assessed in English
- Summary scores from 0-500 then grouped into 5 functional levels



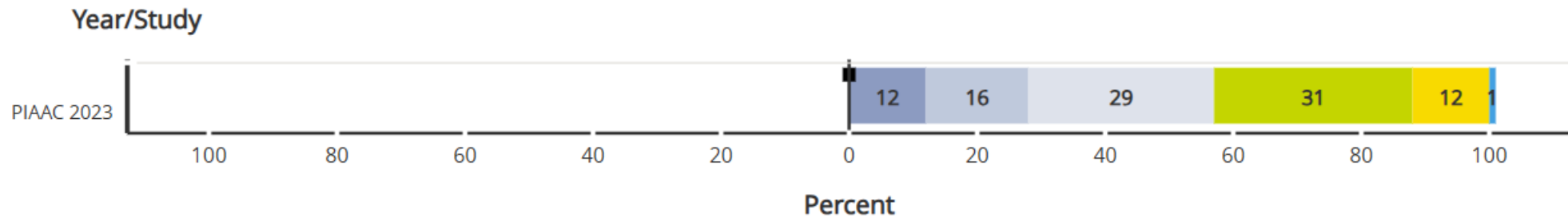
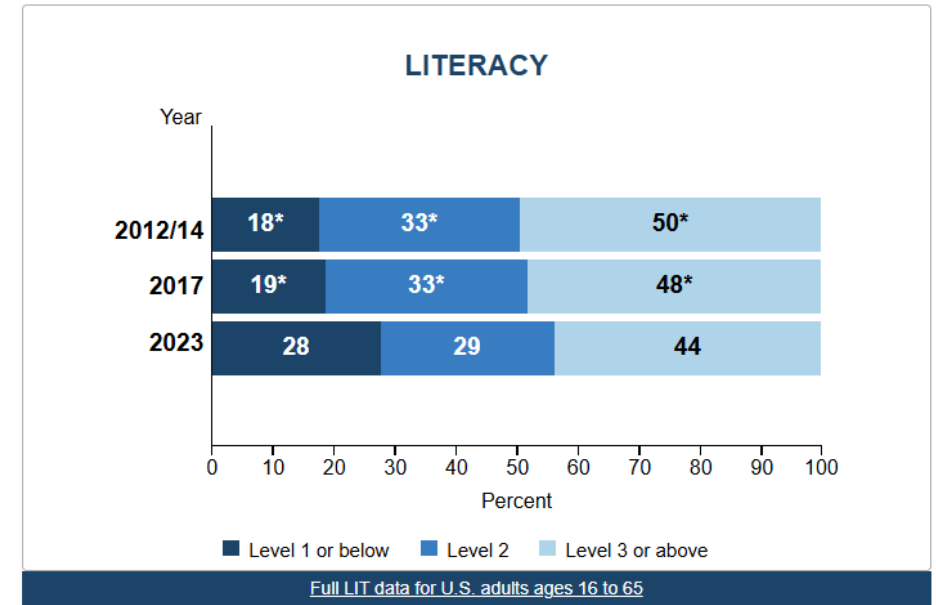
APPENDIX A: Level Descriptions and Sample Tasks for PIAAC Literacy Levels

Below Level 1 <i>Adults at this level:</i>	Level 1 <i>Adults at this level:</i>	Level 2 <i>Adults at this level:</i>	Level 3 <i>Adults at this level:</i>	Level 4 <i>Adults at this level:</i>	Level 5 <i>Adults at this level:</i>
• Can read brief texts on familiar topics and locate a single piece of specific information identical in form to information in the question or directive • Are not required to understand the structure of sentences or paragraphs • Use only basic vocabulary knowledge Tasks below Level 1 do not make use of any features specific to digital texts.	• Can read relatively short digital or print continuous, non-continuous, or mixed texts to locate a single piece of information, which is identical to or synonymous with the information given in the question or directive • Can complete simple forms • Can understand basic vocabulary • Can determine the meaning of sentences • Can read continuous texts with a degree of fluency Texts contain little competing information.	• Can read digital or print continuous, non-continuous, or mixed texts • Can paraphrase and make low-level inferences • Can integrate two or more pieces of information based on criteria • Can compare and contrast or reason about information • Can navigate within digital texts to access and identify information from various parts of a document Some competing pieces of information may be present.	• Can understand and respond appropriately to dense or lengthy texts, including continuous, non-continuous, mixed, or multiple pages • Can understand text structures and rhetorical devices and can identify, interpret, or evaluate one or more pieces of information and make appropriate inferences • Can perform multistep operations and select relevant data from competing information in order to identify and formulate responses Competing information is often present but is not more prominent than the correct information.	• Can perform multiple-step operations to integrate, interpret, or synthesize information from complex or lengthy continuous, non-continuous, mixed, or multiple-type texts that involve conditional and/or competing information • Can make complex inferences and appropriately apply background knowledge as well as interpret or evaluate subtle truth claims or arguments Competing information is present and sometimes as prominent as correct information.	• Can perform tasks that involve searching for and integrating information across multiple, dense texts; constructing syntheses of similar and contrasting ideas or points of view, or evaluating evidence and arguments • Can apply and evaluate logical and conceptual models, and evaluate the reliability of evidentiary sources and select key information • Are aware of subtle, rhetorical cues and are able to make high-level inferences or use specialized background knowledge



Literacy in the United States

- “the ability to understand, evaluate, use and engage with written texts to participate in society, to achieve one’s goals, and to develop one’s knowledge and potential” (OECD, 2013)



(NCES, 2023)



**Below Level 1
~33M**

- Understand simple sentences
- Identify basic words and directly stated information

**Level 1
~42M**

- Locate clearly stated information in short texts, lists, webpages

**Level 2
~77M**

- Find information in longer texts/websites
- Follow instructions
- Compare multiple requirements

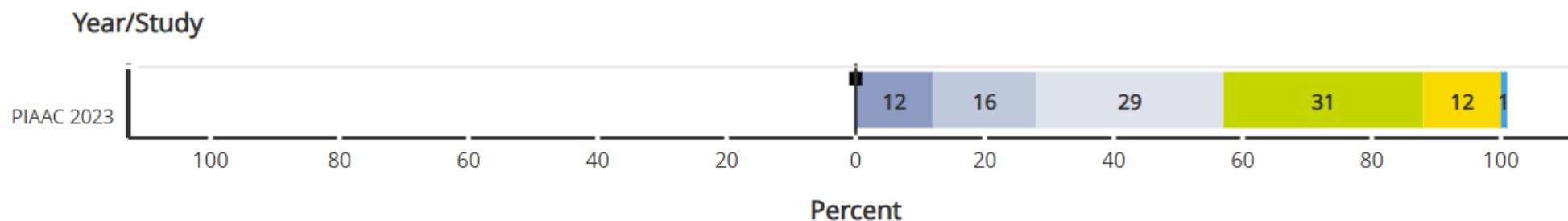
**Level 3
~82M**

- Compare information across texts
- Make inferences
- Identify relevant and credible information

**Level 4
~32M**

- Analyze long, dense texts
- Connect information across sources
- Evaluate evidence and conditions

57%; 151M



Literacy related non-response

Below Level 1

Level 1

Level 2

Level 3

Level 4

Level 5

(NCES, 2023)



Take Home from Literacy Assessments

- ~17% of U.S. adults have literacy skills that lead them to be unable to determine meaning of sentences, read short texts, find a piece of information, or complete forms
- Literacies are often context and content-specific; not binary
- Differences seen across: age, race and ethnicity, educational attainment, geographic locations
- Available materials $\neq$ accessible materials



Differences in functional vs. non-functional literate readers

High literacy	Low literacy
Interpret meaning	Focus on literal meaning of words
Read with fluency	Slower reading, less likely to glean meaning
Seek help for uncommon word	Skip uncommon word
Incorporate context	Focus on text, less so context
Able to persist	High cognitive load → tire more quickly

Differences in functional vs. non-functional literate readers

High literacy	Low literacy	How to manage communication
Interpret meaning	Focus on literal meaning of words	Provide clarity in purpose, meaning
Read with fluency	Slower reading, less likely to glean meaning	Reduce jargon, use language common to audience, examples
Seek help for uncommon word	Skip uncommon word	Provide examples, review language
Incorporate context	Focus on text, less so context	Start with context, give visuals
Able to persist	High cognitive load → tire more quickly	Use short segments of text, use visually 'chunked' text

Best Practices for Material Design (Literacy)

- Overall design
 - CDC Clear Communication Index
 - Core: Audience, Main Message, Call to Action, Language, Design
 - Behavioral Recommendations
 - Numerical Elements
 - Risk
- Readability
 - Readability assessment tools
 - Flesch-Kincaid (1975)
 - Score 100 – 0; lower scores = lower demand
 - Relies on formula using total words, total sentences, and total syllables
 - Dale-Chall (1948)
 - Score 0-10 → <4th grade – 15th grade reading demand equivalency
 - Relies on formula using 'difficult words' compared to 4th grader
 - FOG Index (1952)
 - Gives an indication of the grade level equivalency
 - Relies on formula using average sentence length (#words/#sentence) and percent hard words (3+ syllables)
 - Fry (1969)
 - Gives an indication of the grade level equivalency
 - Relies on 3 samples of text (100 words); formula with number of sentences & syllables



Comparison of the Readability Assessment Tools

Simple Measure of Gobbledygook (SMOG)

- Advantages of SMOG (Compared to Dale-Chall, Flesch Reading Ease, Fog, Fry)
 - Easy to apply in practice
 - SMOG conservative compared to automated version of Flesch-Kincaid (Grabeel et al., 2018, Wang et al., 2013)
 - Highest consistency compared to other tools (Wang et al., 2013)



How to Use the SMOG

1. Identify 30 sentences (10 beginning, 10 middle, 10 end)
2. Count the number of polysyllabic (3+) words in the 30 sentences
3. Take the square root of the count of the polysyllabic words
4. Add 3 to the square root

Table 1: Conversion Table of SMOG Scores to Education Levels

SCORE/ Grade	Education Level
1-4	Elementary School
5-8	Middle School
9-12	High School
13-16	Undergraduate
17+	Graduate

*Adjusted versions for short texts (<30 sentences) and repeated words

(Table: Dergeuch et al., 2018)



SMOG Foundations

- To enhance accessibility, reduce demand of our texts, we should:
 1. Reduce the length of our sentences
 2. Reduce the number of polysyllabic words (3+ syllables)



What do you notice about these common EH terms?

- Exposure
- Ingestion
- Inhalation
- Absorption
- Pollution
- Aquifer
- Bioaccumulate
- Carcinogen
- Emissions
- Endocrine
- Disruptor
- Environment(al)
- Experiment(al)
- Chemical
- Inflammation
- Ventilation
- Ambient
- Monitoring
- Concentration
- Epidemiology
- Assessment
- Persistent
- Confidence
- Prevalence
- Scientific
- Toxicity
- Aerosols
- Allergen
- Asbestos
- Dioxin
- Mercury
- Perfluorooctanoic (forever chemicals)
- Plasticizers
- Polychlorinated biphenyls
- Radiation
- Nitrogen dioxide
- Particulate
- Pesticides
- Parabens
- Triclosan
- Bisphenol A
- Organophosphates
- Polybrominated Diphenyl Ethers (PBDEs)
- Volatile chemicals



“...but we have a highly educated study population”



Scenario: Rewriting a Pharmaceutical Website

- Assessed the impact of writing material for low-literacy vs. high-literacy users
- Rewriting Approach
 - Reduce text to 6-8th grade reading level (prioritize home page for 6th grade)
 - Prioritize information & take-home messages
 - Avoid moving text/dynamic components
 - Streamline most important information (use a single column)
 - Reduce amount of navigation required
- Collected material usability metrics (pre/post) website
 - Success rate (can perform a task with information)
 - Total time to complete 7 representative tasks
 - User's subjective satisfaction with material
- Double-blind protocol: neither participants nor research team knew which material participants were engaging with (old or revised)

(Nielsen Norman Group, 2005)



Scenario: Rewriting a Pharmaceutical Website

	Skill Group	Original Site	Rewritten Site
Success Rate	Lower literacy users	46%	82%
	Higher literacy users	68%	93%
Total Task Time	Lower literacy users	22.3 min	9.5 min
	Higher literacy users	14.3 min	5.1 min
Satisfaction (1-5; 5 best)	Lower literacy users	3.5	4.4
	Higher literacy users	3.7	4.8



(NNG, 2005)



Implications for Practice

- Reducing the demand on the reader benefits all material users
 - Better success rates for use of information to perform tasks
 - Lower time needed to engage with material
 - More likely to engage with it & for longer periods
 - Higher satisfaction scores



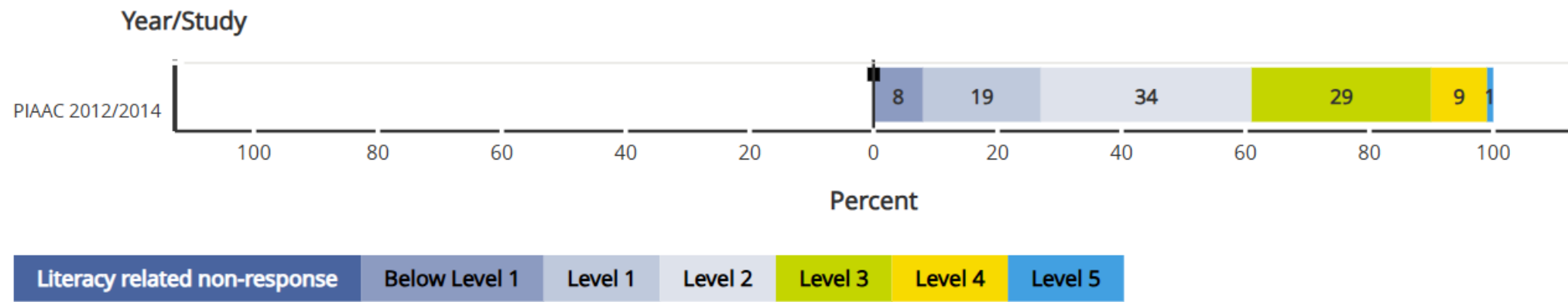
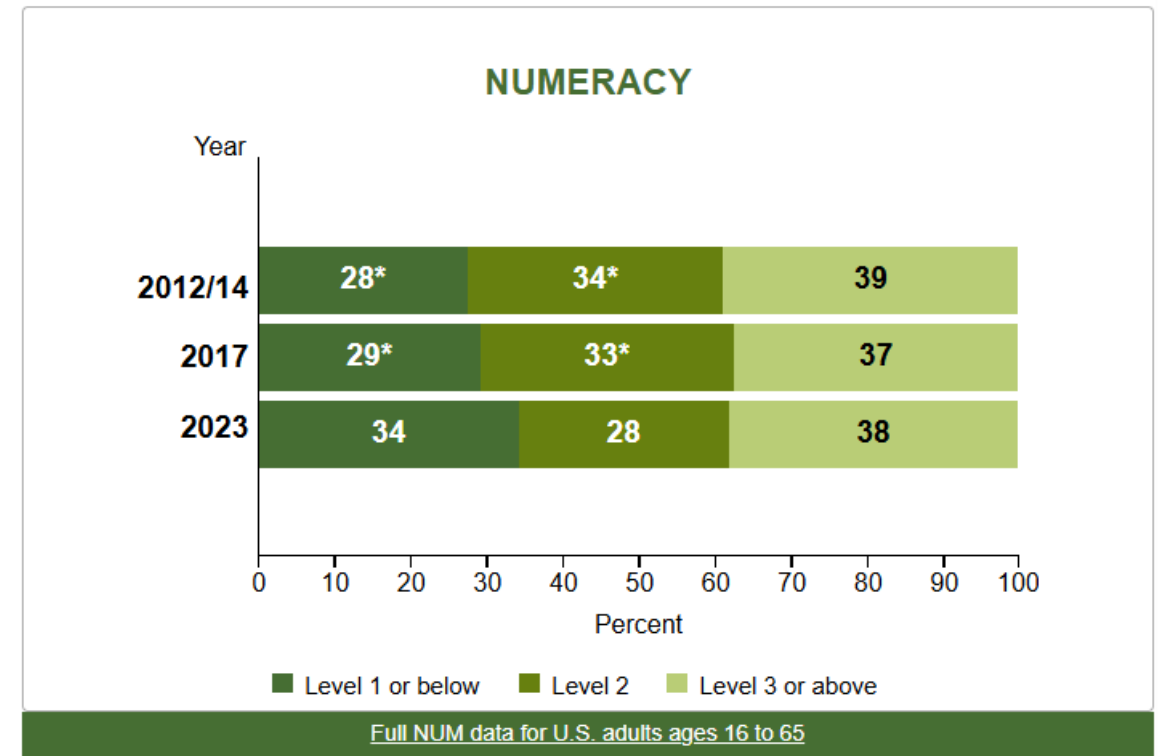
Tailoring Numeracy

1. Numerical Components – Written Materials
2. Individual Numeracy Assessments
3. Data Evaluability



Numeracy in the United States

- "Numeracy is accessing, using and reasoning critically with mathematical content, information and ideas represented in multiple ways in order to engage in and manage the mathematical demands of a range of situations in adult life." (OECD, 2013)



(NCES, 2023)



**Below Level 1
~40M**

- Count or perform basic arithmetic with whole numbers

**Level 1
~50M**

- Complete one step calculations
- Locate and identify information on simple graphs

**Level 2
~74M**

- Apply 2+ steps with whole numbers, fractions, or percentages

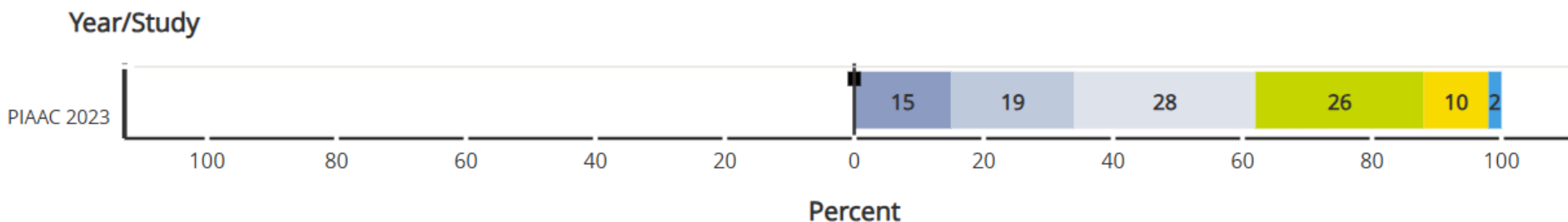
**Level 3
~69M**

- Solve multi-step problems
- Work with patterns or proportions

**Level 4
~26M**

- Analyze complex quantities, spatial relationships
- Choose effective problem-solving strategies

62%; 164M



Literacy related non-response

Below Level 1

Level 1

Level 2

Level 3

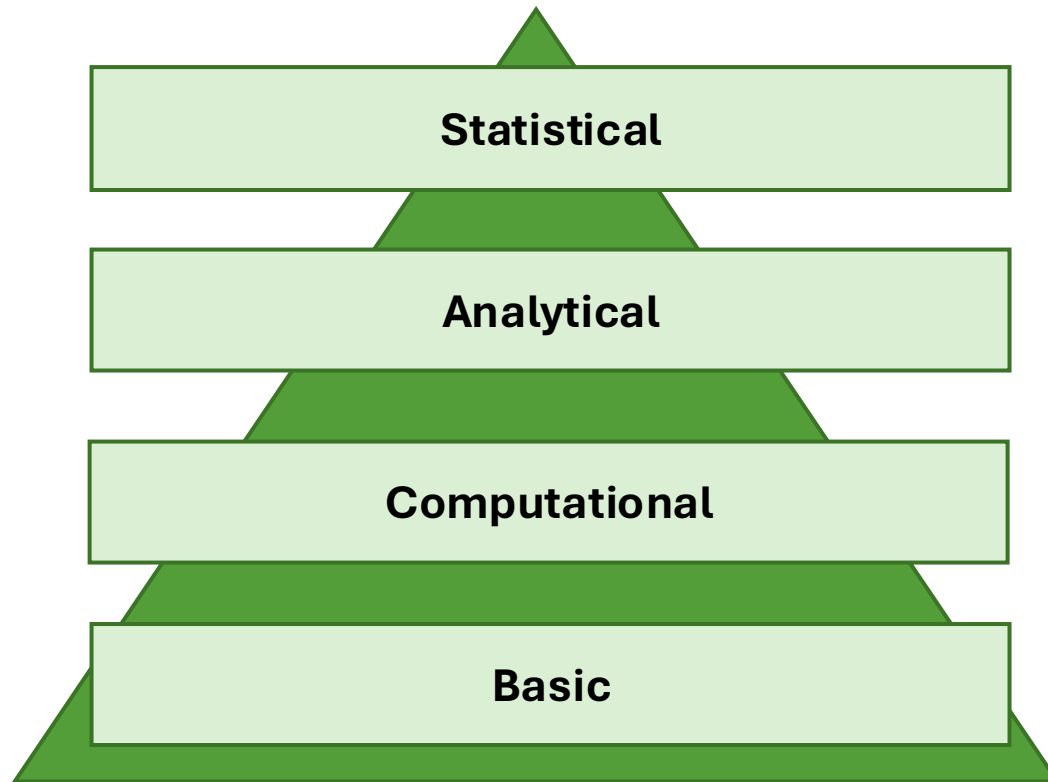
Level 4

Level 5

(NCES, 2023)



Hierarchy of Numerical Skills/Operations

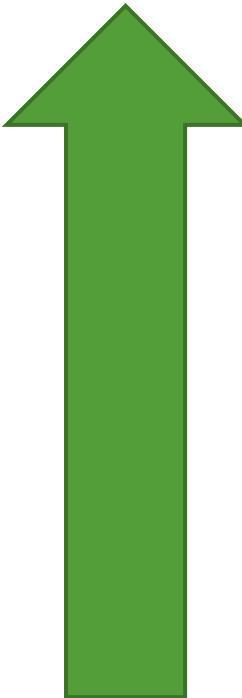


Risk, probability

Estimation, proportion,
inference

Manipulation/calculation of
numbers (arithmetic, division,
etc.)

Identifying numbers



Challenges for Environmental Health Communications

- Contaminants are often unfamiliar
- Units are typically unfamiliar
- Variability vs. single measurement in context
 - Half lives
- Uncertainty in health references/guidelines
- Challenges with causality



Information Evaluability

- Some pieces of information are easier to evaluate on their own
 - We know the directionality of good vs. bad
 - Familiar contexts, details
- Evaluability can change based on the availability/types of reference information
- Some pieces of information are challenging without context/anchors
 - What are the standards to which we can compare?
- **When a material user cannot make ‘meaning’ of a number/map a number onto a scale of good/bad, they cannot make decisions based upon it**



Evaluability Theory

- **Evaluability theory**

1. Evaluability of a value depends on:
 1. Information is considered independently or jointly
 2. Information user's prior knowledge/experiences
 3. Information's inherent ease of interpretation
 1. Are there innate, stable scales?
2. If a value is easy for communicators to evaluate, they tend to overestimate others' interpretability (curse of expertise)





Of these sauces, which would you put the most of on your chili?





Of these sauces, which would you put the most of on your chili?





Of these sauces, which would you put the most of on your chili?



How could we design more effective communications with hard-to-evaluate data?

- As communicators, identify data characteristics that help facilitate evaluation and contextualization of data
- List of types of context and information navigation tools that help decode a value in a given situation
- Communicators should determine the contextual information that will enhance evaluability in line with the audience's needs



Data Evaluability Worksheet

Table 1. Data Evaluability Characteristics Worksheet.

Background:

- What is the technical term used to describe this test or measurement?
- How is this test/measurement commonly described, if different from the technical term?
- Who is the target audience for this communication?

Data evaluability characteristics:

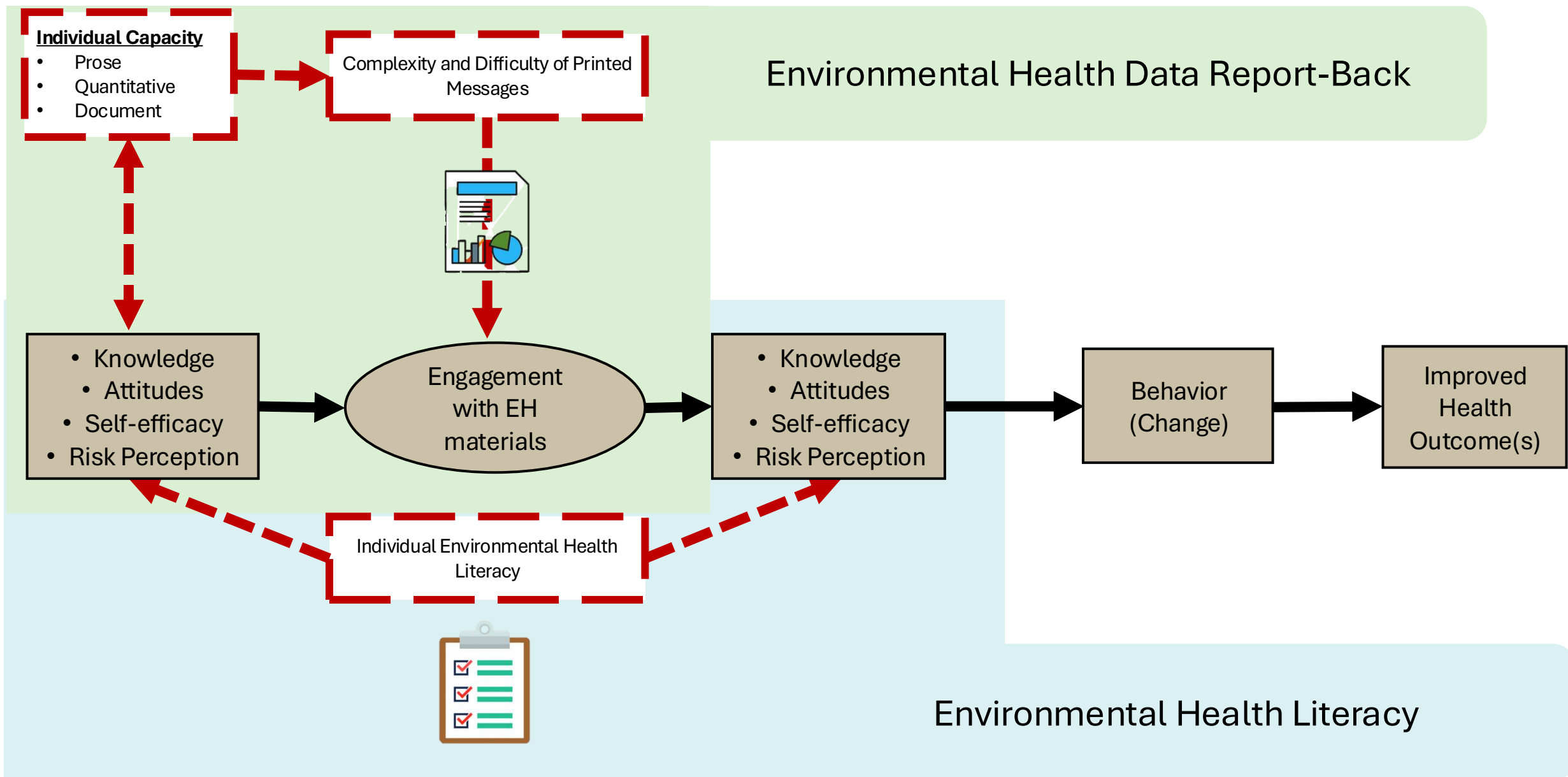
- What units are commonly used for reporting measurements to this audience?
- What is the direction of improvement (higher/larger always better, lower/smaller always better, optimal range)?
- What is the theoretical range of values?
- What range of observations is commonly observed?
- How much change in the value (in terms of the commonly used units) represents a clinically or practically significant change?
- Are there action or harm thresholds established or commonly used?
- Are there established target/goal levels or ranges?
 - If yes, is the target or goal the same or different for different people or observations?
- Is there an established categorization scheme for these values?
- Are historical values for this participant/source available?
- Are population norms available (e.g., mean, median, standard range, normal range)?
- Are there other key observations that this observation should be compared to (e.g., other locations)?
- Are percentile scores or other measures of relative position available?

Communication goal:

- Which of the following is most important for this audience to understand? (Pick ONE: result absolute level, result historical trend, result relationship to threshold, result categorization, result relative relationship to other observations, trends, or norms)

(Zikmund-Fisher, 2019)





What Can We Say About Our Materials' Suitability for our Audience?

Material Development/Assessment

- Formative research
- Literacy Demand
- Numeracy Demand
- Document Complexity
- Data Evaluability
- Material Design

Audience Assessment

- Formative research
- Health Literacy
- Numeracy Skills



EH Communication Challenges in Practice

Communicating Risk

- Timing
 - When is there sufficient information for communication
 - Meaningful connection between exposure data & data communication
- Uncertainty
 - Ethical study designs in EH; RCTs?
 - Extrapolation from animal models to humans
 - Emerging contaminants
 - Establishing health standards/thresholds
- Messengers/Channels
 - Balance of expertise vs. trusted resource
 - What does risk mean, and to who? How do we communicate it?

Assessment

Assessment

- How do we know if we've had an impact?
- How do we measure non-observable ideas or themes?
- What questions do we ask in evaluations?
- What is the usefulness of measuring general EHL vs. topic-specific EHL?



Areas for additional inquiry, assessment

- Are there specific stages of EHL that are amenable to intervention?
- Does raising EHL correlate with improved health outcomes?
- What is the relationship between EHL and resilience?
- What is the effectiveness of EHL resources and educational materials to inform intended audiences?
- What approaches work to measure success?

Areas for additional inquiry, assessment

- What is the level of cultural acceptance of environmental risk messages in different ethnic and socioeconomic settings?
- What is the sustainability of evidence-based tools to raise EHL?
- Does risk messaging about environmental exposures lead to behavior change?
- Does risk messaging lead to prevention/reduction of environmental risk factors?

Areas for additional inquiry, assessment

- Skills: individuals, EH professionals (data presentations, written materials, verbal communication)
- Texts: data displays, numeracy demands, surveys, etc.
- Tasks: Assessment of demand of EH-related tasks (seeking information, adopting behaviors, etc.)
- Environments: How can organizational and structural changes impact EHL?

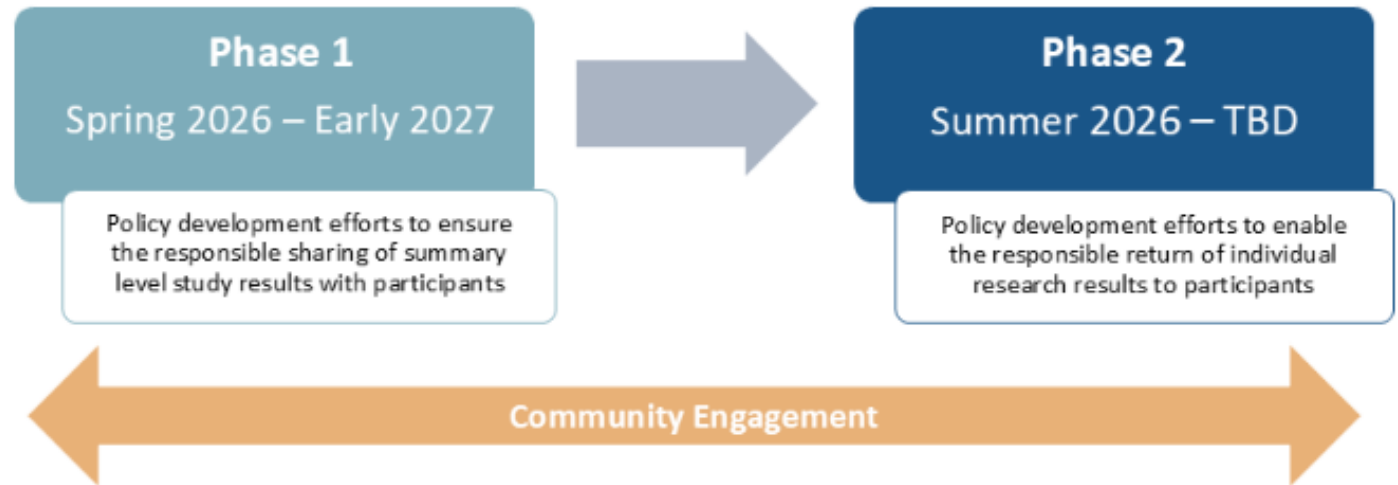
Why This Series

What's Next: Making Return of Results Standard Practice

While NIH has some programs actively engaged in returning research results to participants, it does not occur consistently in practice across the clinical research enterprise. To address this inconsistency, NIH is working with the community to develop a policy framework to make the responsible return of research results standard practice.

OSP is embarking on a two-phase policy development process that will directly engage the community.

- Phase 1: This phase aims to build upon previous efforts and existing best practices to develop a policy to ensure the responsible sharing of **summary level study results with participants** (Spring 2026 – Early 2027). More information on Phase 1 can be found [here](#).
- Phase 2: Informed by the outcomes and lessons from Phase 1, this phase aims to develop a policy to enable the responsible return of **individual research results** directly to participants (Summer 2026 – TBD).



(NIH OSP, 2026)



Why This Series

Draft NIH Policy on Sharing Summary Level Study Results with Clinical Research Participants

In Spring 2026, NIH began a comprehensive policy development process to establish requirements for researchers and institutions to responsibly share summary level study results with research participants in plain language for all NIH-funded clinical research. This involved hosting a public [webinar](#) and inviting on-demand commenting to inform the draft policy.

On August 27, 2026, NIH released its Draft NIH Policy on Sharing Summary Level Study Results with Clinical Research Participants for public comment. Comments on the Draft Policy will be accepted until **October 26, 2026**, and must be submitted through the form below.

- [Draft NIH Policy on Sharing Summary Level Study Results with Clinical Research Participants](#)
- [Comment Form](#)

For more information on the timeline for the Draft Policy, please see below.

Summary Level Study Results Policy Development Timeline



(NIH OSP, 2026)

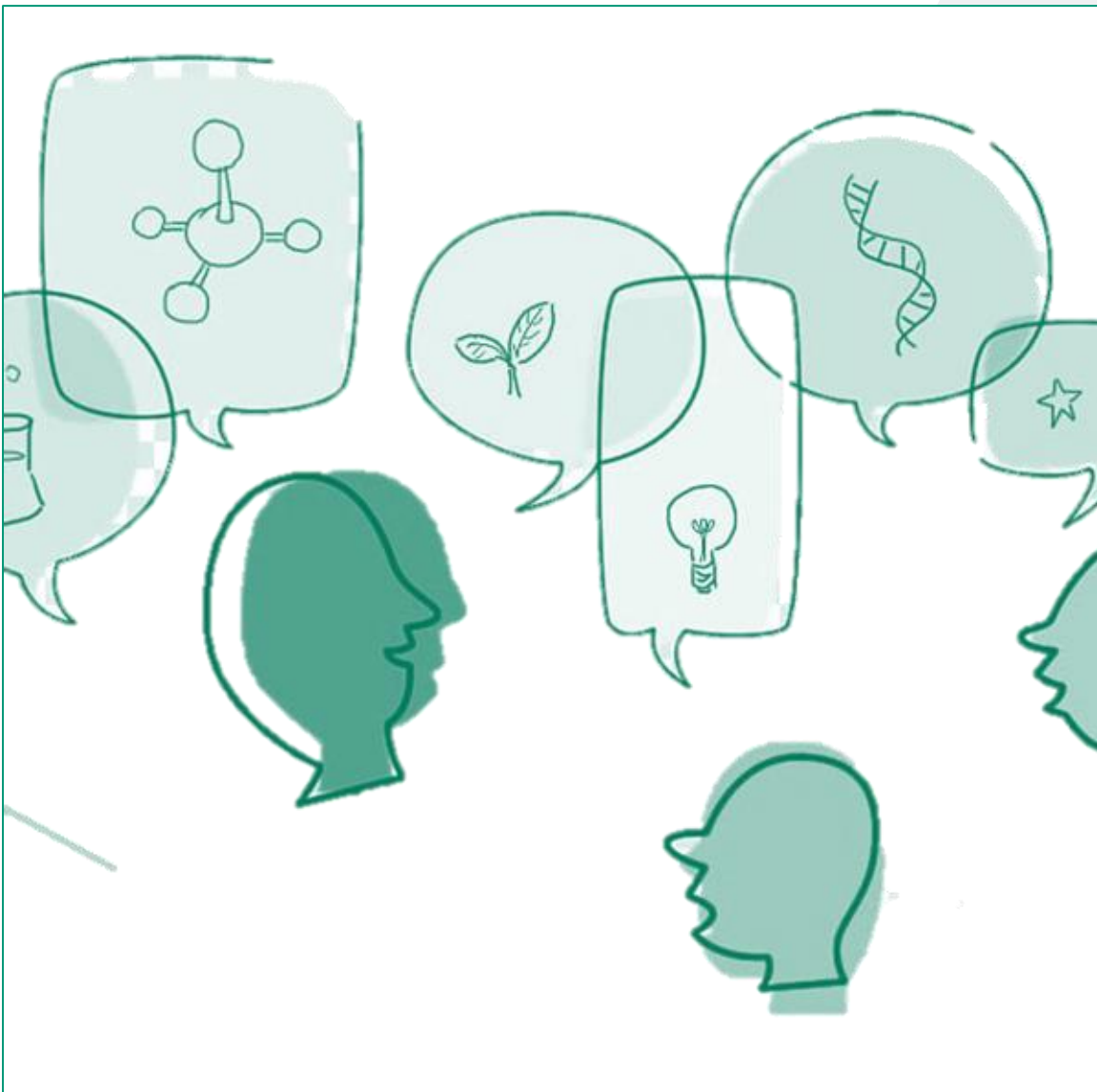


Where to Start?

- **Before data collection:**
 - Provide an opt in/out option for results return
 - Ask how participants would like to receive results
- **During study:**
 - Maintain contact and provide updates, provide clarity for expectations
- **After analysis:**
 - Brief, accessible summary of results; channel for questions/follow up

Planning for communication starts before data collection





Questions?

ktomsho@hsph.harvard.edu



Harvard Chan NIEHS Center
for Environmental Health
Science Communications Hub