Write an outline/framework to make sure that when I meet with Ellen Peters, what can I find out on my own, and what else specific questions can we try to answer and address in the literature?

* Try to make sure it’s not too long! 2 to 3 questions MAX??
* It might not even be there in general, but she can try her best!

What question do we want to address?

* How to communicate/convince low numeracy individuals
* Do low numeracy individuals follow a different mental process?
  + If so… what is it, why is it, and what can we do about it (is it good or bad?)

We saw that numeracy moderated the effect of the intervention!

Innumeracy in the Wild

Ch 15: Evidence-based information presentation matters!

* Forms and types of information presentation are critical and useful
  + We could create a simplified abstraction (that doesn’t directly reflect truth as closely) that is more useful as a model?
  + Baruch Fischhoff – What is the goal of the communicator?
    - Here, our goal is to ingrain an understanding of the necessary trade-offs in UHC, and by illustrating this, hopefully improve comprehensibility and perceptions of fairness.
    - We might be able to improve this by somehow ‘reducing cognitive effort’… Is there an important balance between ‘realism’ in simulation for our model, and applicability in terms of human use, engagement, and understanding?
    - Although the effort in and of itself might be part of what’s generating value??
* “We can make the Hurdle shorter, or the Runner stronger”
  + Implies that there isn’t a categorically different approach that may work better?
  + Note: We can’t make people numerically ‘stronger’ here.
  + Hurdle Shorter : Improve ‘information’ architecture. Similar to choice architecture in the JDM literature.

Reflections on Innumeracy in the Wild

* The less numerate rely more on compelling concrete stories, images, and emotions, to make their decisions.
* Numbers often neglected by less numerate or those using superficial heuristics (which heuristics would be used in our case here?)
* Subjective numeracy research indicates that low confidence in subjective numeracy tends to lead to less math ability being used, even if objective math skill is good
  + In our example, subjective numeracy had no effect, but objective numeracy had a large moderating effect!
* “Relying on a simple mental shortcut once is efficient and often produces a decision that is good enough. However, when employed again and again, heuristic use seems to be a risk factor that accumulates over time and causes worse outcomes.”
  + Really unsure if we agree with this quote, but could look into more about what Ellen actually means when we chat about it. Is time sensitivity one of the critical criteria? If so, heuristics improving decision making overall under time constraints could be a net positive, instead of just making a choice regardless without any time to choose.

Summary Table

* Choose information presentation formats strategically – Test communications
  + Implies that perhaps same material, presented in alternative fashion, would do well?
  + Look into literature about presenting numerical information, perhaps an alternative to trying a non-numeric method (as that doesn’t directly address our potential mediating factors)
* Reduce Cognitive Effort
  + Provide fewer options, less information. This means a simplified version of the exercise?
    - Perhaps reach out to original designers to see what we can do here.
  + Do the math for them.
    - In-built calculator not enough? Perhaps some example plans?
  + Use appropriate visuals.
    - Unsure, but perhaps designing different structure for the game or presentation itself?
* Perhaps add a column/exercise indicating how much individuals actually used the given health options in a year, and whether or not they would be happy if the plan selected was what they had?

Ch 16: Provide Numbers but Reduce Cognitive Effort

* Can correct people who have wrong facts
  + Is there a subset of people who don’t support UHC due to incorrect factual reasons?
  + If the ‘scope’ of facts is very large, providing information can be like drinking from a fire-hose, not particularly plausible.
* Can correct inappropriate interpretations: Not really sure how this applies here?
* Can help people avoid being surprised by an unexpected event and possible regret and anger that can follow
  + Perhaps adding in information about base rate of occurrence of various categories of harm, in ADDITION (or alternatively?) to information on what is covered.
  + Emotion can divert attention from unlikelihood of an event if numeric likelihood is not emphasized
    - Here would be the effect of affect on choices and priority setting in medical care
  + Perceived as more useful - ??? Unsure

Perhaps we can add a table translating meanings for probability (look at the IPCC 6 climate change report on how they used various terminologies)

* If so, would the ‘colloquial’ labels be more useful than hard numeric ones, if provided with an additional table?
  + Data shows that people CANNOT use the IPCC table to translate meaning, and estimate risk improperly.
  + Straight numeric information prevents this from occurring however.
* The less numeric can still make use of this provided numerical information
  + But not as well as those who are highly numerate
  + This may NOT be a categorical type issue regarding communication?

Provide uncertainty in data

* Unsure how to use this regarding the numerical information provided in the study

Reduce cognitive effort

* What choices are relatively important? Would a simplified version of the exercise make sense, with less options and less choices (commonly chosen items could be pre-selected as the ‘default’ for the majority of people?)
* Options can be presented sequentially?
  + This doesn’t work when doing a choose n problem, because each step requires trading-off and optimization, you can’t choose A over B if it affects your choices of C over D, unless you know about the 2nd choice.
* How to determine which elements here are ‘critical elements’?
  + Perhaps get some feedback from clinicians?
* Provide absolute risk
  + If we were going to add relative likelihood of risk of various occurrences under the chart, we need to do it in an absolute risks framework.
* Use a ‘fixed’ denominator when looking at risks – This plays into our absolute risk, 1 in 1000, 10 in 1000, 30 in 1000, etc.
* Use numbers in a direction consistent with people’s expectations

DO the math for them

* When presenting cumulative risk, communicate the cumulative amount outright
* Use graphs or some type of visual
  + Perhaps a moving scale or bar showing how relative expenditures are used, or how many resources are left?
  + Maybe simple icon arrays indicating how much something would ‘cost’ in resources?
* How to ‘experience’ hypothetical risk?
  + Could show various images of dealing with medical problems as part of the exercise?
  + Didn’t replicate for Ellen Peters… how and why, what elements? (ref 125)

Ch 17: Provide Evaluative Meaning and Direct Attention

* In unfamiliar domains, we must be able to identify correctly what a number is without having clues to what it means for your decision
  + ????
* Difference b/w comprehension and comprehendability = decision maker cannot map a numeric value onto good/bad scale.
  + Providing evaluability means data = meaningful information to make choices
* Can either ask individual to estimate a number, and then show them the real value, or just directly show them the real value
  + The contrast has some benefit, mainly active comparison changes how people process information (especially if they tend to over or underestimate the true value)
* Attributes that are difficult to evaluate (fertilization clinic distance vs success rate) without context, subjects might overvalue the thing that is at least somewhat comprehensible.
  + Highly numerate people SOMETIMES use comparative information more, but the research is mixed.
  + E.g. Graphical presentation of risk is useful for highly numerate, but not the less numerate (insensitivity to risk levels) (ref 34,35)
    - Unless it’s a highly simplified graphic? (ref 30, 36)
* Providing more risk information affects the perception of the numeric risk level
  + This ‘unpacking’ of risk factors affects only the less numerate, a potential alternative to increase perceived relevance and elaboration of numeric risk (or we can use narratives?) (ref 38)
* Numeracy effects are less likely to emerge when motivation is HIGH and when concrete, easy to evaluate comparisions are provided.
  + MORE likely to emerge when numbers are seen as less trusted, are complex, or require math calculation.

Carefully use evaluative labels/symbols

* Evaluative labels improves risk comprehension (high, low, med, instead of 15, 10, 5% which can be hard to contextualize)
  + It seems to do so by changing participant affect.
* But people can over-react to evaluative labels as well, which is likewise a problem.
  + Decreases understanding of specific information; can lead to value-inconsistent choices and risk perceptions.

Frequency vs Percentage formats

* Less numerate finds that medicine is less risky when side effect info presented using percentage instead of frequency.
  + Perhaps b/c frequency formats = greater emotional feelings vs percentage formats?

Use other more Imagineable data formats

* Instead of presenting disease risk change, perhaps present life expectancy change? This is more comprehensible to average person and directly relevant as well.
* Analogies are very useful because they are very comprehendible for most people if well formed.
  + Lead to improved understanding of medical problems

Leverage Emotion to get attention, information, and motivation.

* Emotion has value! Emotion is information, informing perceptions of risk quickly and efficiently
  + Spotlight in 2 stage process, emotion highlights information, then information affects decisions.
* Order information such that the most IMPORTANT item is FIRST or LAST
  + Effect MAY be greater amongst the less numerate?
  + For very complex information, ordering plans lead to greater comprehension only for the more subjectively numerate (e.g. ordering medicare plans by benefit and generosity)
* ONLY highlight the most IMPORTANT information using symbols
  + If you highlight everything, even the unimportant stuff, the less numerate do worse.
* Summaries can provide an overview
  + BUT it harms comprehension of outside of framework information
  + Summary evaluation can work instead?
    - Summary of each hospitals evaluation helps make choices for the less numerate, when looking and comparing multiple hospitals along many axis.
* Improve visual salience (UI stuff)
  + Greater contrast, larger font, etc.

OVERALL

* Use presentation approaches for things that people SHOULD care about more (quality of health insurance for example)
* Use graded performance standards
  + But this requires expert judgement / consensus
* Pop short in general education based numeracy skills (arithmetic, cumulative risk, etc.)
  + But ALSO short on emergent decision-based numeracy skills (finding numeric information, deriving affective meaning from it)

Peters 2007: Numeracy Skill And The Communication, Comprehension, And Use Of Risk-Benefit Information

* Informed consumer choices are good, but uncertainty exists! How do we deal with innumerates who are not well calibrated.
* Why is numeracy important to health care decisions SPECIFICALLY?
* A good chunk of smart people incorrectly answered questions about risk magnitude (what’s greater, 1%, 5% or 10%?)
  + Similar questions might be a good tool to use to gauge… attention? This seems almost too obvious to get wrong.
* Types of uncertainty for health decisions
  + Uncertainty in health care settings: Uncertainty about magnitude of risks and benefits. Uncertainty about strength of evidence.
    - People accept or reject information fully, without adjustments for data quality or thinking on a continuum.
    - Uncertainty about how to weigh risks/benefits in choices
  + Skill needed to understand risk-benefit info
    - Information needs to be available, accurate, and timely.
    - Patient has to be able to asses tables, charts, and text.
    - Patient has to make calculations and inferences from this information.
    - Needs to know how to weight their needs/values.
    - Has to make choices under context of high affect.
* Difficulty evaluating risks and benefits of health options
  + Conceptually, this is a plausible explanation for why the non-numerate had less effect, that is NOT related to the more numerate being more engaged or attentive.
  + Quantitative descriptions are necessary, because qualitative descriptions are TOO ambiguous.
* Weighing short-term against long-term benefits
  + Could be impactful… but it assumes that the innumerate are thinking about and able to evaluate the relative cost and benefits of the selections at all, and THEN also have a perception of short vs long term.
* Best practices in presenting numeric health information
  + Less is More!
    - Can present simplified version of tasks?
    - Perhaps a sequence of left or right, this or that, and eventually after the carousel of choices has finished, the plan is there and the person made it over an aggregate of choices?
    - ALSO! Only simplifying the important elements, instead of the less relevant choices, generally leads to better choices (b/c subjects will upweight the simpler, but more important, information?)
    - Can mark the solid or easier to evaluate/more important section w/ symbols, like color coding, check marks, stars, etc.

Numeracy and the ACA: Opportunities and Challenges

* Numeracy levels in the US are super low
* Three main questions

Question 1: What does research show about people’s Numeracy Skill Levels?

* Different levels and scales of quantitative literacy, from below basic, basic, intermediate, and proficient
  + Proficient is seen as what is needed to make good health care choices in the marketplace??
  + 22% are below basic, 33% basic, 33% intermediate, and 13% are proficient.
* Dual process theory: Effect of time pressure, stress, illness on health numeracy
  + Affective engagement can change ability and resources available to engage in critical thinking.
  + Health problems can both directly and indirectly impact the capacity for thinking in the dual process concept.
  + Numeracy is measured under NORMAL circumstances, if ABNORMAL circumstances are standard for health concepts, then there is a risk of this reduced numeracy hurting people specifically making health choices.

Question 2: What Numeracy skills are needed to select health plans, choose treatments, and understand medication?

* Understanding of numeric information is necessary, arithmetic, basic computational skills, frequencies, etc.
* Less numerate are vulnerable to format effects, changing ratios and such.
* Probabilistic reasoning is needed for calculation of risk and likelihood
* Greater attending to numeric information is something for highly numerate as well.
  + Generally, the original task seems to need at LEAST basic information, and perhaps even as much as proficient?
* The less numerate have additional pessimism regarding factual information provided – in the form of cancer risk and perceptions.
  + E.g. the more numerate were also pessimistic, but their odds hewed closer to the true value.

Example – Skills needed for Health Plan Selection

* Consumers need to know what the terminology itself means.
* Basic skill allows for lowest cost plan based on premium and deductible
* Intermediate skill allows for evaluation of co-insurance costs and costs of treatments.
* Complex calculation, estimating annual costs and estimated out of pocket expenses require significant proficiency.

Example – Skills needed to select Treatment for self

* Some ambiguity behind treatment costs and difficulty to obtain them.
* Below Basic allows for comparison between generic and name brand price
* Basic allows for estimation of survival rates when given percentage survival
* Intermediate allows medication cost comparison between different dosage and units
* Proficient allows cumulative risks and benefits accurately

Question 3: What do we know about how providers should communicate with those with low numeracy skills?

* Ancker et al., 2006; Apter et al., 2008; Berkman et al., 2011; Fagerlin and Peters, 2011; Fagerlin et al., 2007a; Hibbard and Peters, 2003; Lipkus, 2007; Lipkus and Hollands, 1999; Peters et al., 2007a).
  + Various compilation of papers describing how to communicate numeric information
  + Mostly coming to the same conclusion



* Provide numeric information
* Reduce effort
* Provide evaluative meaning
* Draw attention to important information
* Set up appropriate systems
* Fewer options
  + if only certain options are valuable or important, you should maybe try presenting only them
* Provide less information
  + Any information that isn’t important should be removed
  + Perhaps try a ‘slimmed’ down version of the experience?
* Use appropriate visuals
  + Pictographs or icon arrays can indicate how much likelihood of having an issue
  + For common outcomes, bar charts are good!
* Use evaluative labels when you want to get some action happening!
* Order information such that the most important information is first or last
  + Important meaning here… largest cost or potential for cost?
* Use fonts that draw attention to important information
  + Mostly UI and visual design choices for our intervention itself?
* Ensure and Identify the goals of the communication
  + Make sure to clearly re-iterate what this is, and have it inform the core of the design itself
* Use defaults?
  + Provide a ‘default’ plan with most of the selections already made, and then see if the person themselves wants to alter the plan??

Panel 5: Strategies for Effective Communication

Krughoff – Consumers Checkbook

* Key features for communication about the ACA
  + Single dollar amount actuarial estimate of average total cost
    - INCLUDING premium and out of pocket costs for people with SIMILAR characteristics to the consumer, MUST be provided.
    - INCLUDING ‘range of risk’, how much a cost could be for a good or a bad year, and relative likelihood of having those years.
    - Summary rating for each plan’s care and service quality, but adjustable based on what the patient themselves values
    - Overview showing which doctors are available under which plan.
  + ‘Benefits description model’ is most common cost comparison tool
    - However, many consumers CANNOT understand the terms and CANNOT do the calculations required, when provided deductibles, copayments, etc.
  + Known-usage model is alternative.
    - Compares plans by having consumer estimate their actual use of provider visits and prescriptions
      * Is there a much simpler way of doing this? Perhaps just pro-rating for a given week, or a month, out to an entire year?
    - Model estimates costs of these services, but it’s VERY time consuming to do for the entire household.
  + Enroll UX2014 another options
    - Asks consumer preferences, then filters plans based on those preferences
    - HOWEVER, a consumer might not know how their answers cut off or prioritize different things, with false assumptions by the consumer a very common issue.
    - It is VERY challenging to design a quality comparison tool that does not require strong literacy or numeracy skills!
  + Consumer Checkbook uses 5 star rating system
    - However, two plans that are very different in some categories may still be the same star rating.
    - Some plans might have small differences b/w things and end up in DIFFERENT star ratings!
  + Too much detail leads to consumers being ‘disengaged’
    - Tyranny of choice
  + Consumer’s Checkbook Tool
    - Asks total health status (is a strong predictor of health services usage)
    - Asks for predictable procedures (childbirth, hip replacement, etc.)
    - C.f. names of doctors that are currently being seen, to see if they are ‘in plan’
    - Presents results by highlighting average yearly costs (combo of yearly premium, tax subsidy, and out of pocket costs).
      * Also presents minimum and maximum range that a consumer could pay.
    - This is what people’s surveys and ratings claim that they want, in the way they want it?
    - Can specifically request particular services, or ignore plans that have certain categories of characteristics.
  + Key element: Allows consumers to keep the format simple and allowing THEM to decide the level of personalization and detail

Brian Zikmund Fisher: Why are you giving me this number? Communicating quant info for decision making:

* Person could find information about themselves, that they have 14.52% chance of cardiovascular disease – Is this number GOOD or BAD?
  + It could be the most accurate estimate in the world, but this does not provide the person the information they actually want.
    - Integer risk (15%) would be perceived as more believable and easier to remember.
  + There is a lack of ‘information evaluability’
    - The meaning of this number depends on context, the number itself cannot be evaluated without context or reference standards.
    - Health professionals are trained to have contextual knowledge for numbers, but patients are NOT.
    - Not everything is hard to evaluate, expensive things, time, etc, are all things that a person themselves can consider.
    - Hard to evaluate data without a reference is GENERALLY ignored
      * Make sure the important elements have reference standards then?
      * Could we just give a topline – compared against health availability in other countries, for other citizens?
    - Perhaps give harm thresholds, or anchors for action given certain values.
    - Iconarray.com is a tool to make some icon arrays for comparison?
  + Risk communication CAN be simple when describing all possible risks, however, risk that adds motivation to ask, means categorical communication that aligns with that goal!
    - Give people the ‘right tool at the right time’
  + Ensure that there is not TOO Much information
    - What numbers are needed, what is necessary, what is important, especially if there is a trade-off b/w two courses of action!

Thompson 2022: Leveraging Math Cognition to Combat Health Innumeracy

* Natural number bias, tendency to apply knowledge about natural numbers to all numbers, is underlying other biases behind decision making.
  + Automatic processing of natural-number magnitudes and not ratio magnitudes
  + Advise some alternatives when presenting information
* Ratio bias, 1-in-x phenomenon, or denominator neglect, is very common
  + AKA the natural number bias in math cognition.
* We can prevent innumeracy downsides by implementing interventions that help individuals think more deeply about the magnitude of rational numbers.
* Generally – Natural number bias is due to lack of training on *relative* magnitudes vs *absolute* magnitudes.
  + Natural number bias can affect even highly numerate!

What underlies natural number bias?

* Perceptual limits – A person can see 4 > 2 much faster than 104 > 102, even if objective difference is the same.
  + More distance b/w numbers, easier to discriminate b/w them.
* Natural numbers are very common
  + ½ are seen much more often than 15/30 for example, as 1 and 2 are super common numbers!
  + Even in adults, 300 pennies is seen as worth more than 3 dollars

Natural number bias is the overarching phenomenon

* Various biases are in fact the result of natural number bias.
* Inability to engage in relational reasoning (considering concepts in isolation rather than in relation to each other)
* Subjects directly mention that they focus on numerators in isolation, and that covid lethality was undersold as it compared absolute numbers to flu deaths.
* 1 in x phenomena likely due to the heuristic, smaller components = larger magnitude, simply that larger denominators are smaller magnitudes.

Is natural number bias always bad?

* Can some contexts be such that automatic processing of natural number components = a better strategy/more efficient than computing the ratio magnitude?
  + Choice of strategy to use can and will change over time
  + Comparing two unit fractions in pure numerical context, ½, 1/3, ¼, 1/5, etc. smaller components = larger magnitude quite clearly here.
  + Can ask people to compare unit fractions to each other instead of other types of fractions?
* Misperception of risk can still prompt someone to adhere to recommendations for health??
* 1 in x format can lead to overestimation of personal risks
  + Which again… may be good if it spurs patients into action?

Percentages

* A solid alternative to 1 in x
* Involves a common denominator (by the 100)
* Percentages perceptually look like whole numbers (even tho they represent fractions)
  + Allows for benefits in natural number processing!
* However… can’t add up multiples of percentages so easily, 10% then 20% off is not 30% off.

Consistency in Measurement and Accounting for Individual Differences

* Some of our measures of objective numeracy require math solving problems
  + Which can tilt some people out, regardless of their actual math skill
  + Objective numeracy scales often have WORD problems as well, which isn’t necessarily good either.
* Subjective Numeracy is faster to get, and is correlated w/ objective numeracy
* These predict health decision making exactly b/c they relate to understanding of ratio
  + Obj = ability to calculate ratios
  + Subj = willingness to work with fractions/percentages
* Measures of math skills MUST incorporate knowledge of ratios!
* Some other measures from the field of math cognition could work well!
  + Number-line estimation task, estimation the location of numbers on a number line
  + Measures adult’s symbolic number mappings (Peters & Bjalkebring 2015) from 0-1,000
  + More useful to have number lines that include fractions, b/c rational number understanding is EXACTLY how health statistics works!
* Directly can measure math anxiety
  + Apprehension around math that occurs in the presence of numbers. Can reliably be assessed with one item (see Ashcraft, 2002; Núñez-Peña et al., 2014)

Educational Interventions to Improve Risk Interpretation

* Visualizations are good, e.g. icon arrays and risk ladders
  + Because these visuals allow to view statistics as percentages, which can be interpreted very easily.
  + Works well in ‘isolated’ situations, but how do you evaluate health info without visuals or cognitive supports??
* Health decision-making literature “recognizes that clinicians do not have time to teach patients about math”
  + Instead, they prevent activation of numerical biases
  + Promote use of non-cognitive processes (visual perception and icon arrays)
* Teaching how to do math is a long-term strategy, that is a societal type issue.
  + Does not rely on needing a well-designed visual display

Magnitudes are the GIST of rational numbers

* Understanding of magnitude is the building block of math
* Gist of magnitude allows people to estimate what is needed for good decisions.
* GIST usage increases with age.
* Reasoning w/ fractions.
  + Strategic and effortful reasoning is needed
  + Thus, learning goes from the gist understanding (rough magnitudes) to exact information, to using gist reasoning by considering approximate magnitudes.
* Number lines illustrate magnitude
  + Thus both primes subjects to use the ‘correct’ skills
  + Also allows for comparison of magnitudes to each other very easily
  + Leverages spatial-numeric relationships.

Interventions for Adults

* Combination of procedural instruction (step by step how to do activity) as well as conceptual instruction (what is relative to what, base rates and other numbers, etc.)
* Conveying conceptual information to explain why the procedures work the way they do Thompson et al. (2021)
  + Could we expand this even further when explaining our goal??
  + Could we add some basic costs and see if this is realistic to address?
    - Would people want less or more than the ‘pre-set’ budget, would knowing the monthly cost and value of each service in and of itself help drive decision making?