The Knowledge-Method Matching Matrix (KMMM)

Considering the Condition of Knowledge When Choosing Research Methods

Derek Cabrera[a,b,c] **and Laura Cabrera**[a,b,c]

[a]Cornell University; [b]Cornell Human Ecology; [c]Cabrera Research Lab

Abstract: The Knowledge-Method Matching Matrix, or K-MMM, is a simple heuristic framework for making the relationship between the *condition-of-knowledge* and the *choice-of-methods* in the pursuit of new knowledge when choosing one's methods.

K-MMM | research methods | condition of knowledge | epistemology | evolutionary epistemology

1. The Problem With Research Design

The misguided training of doctoral students often leads to the widespread belief among researchers that experimental designs (EDs) and randomized controlled trials (RCTs) are the "gold standard" of research. This belief persists throughout their careers. As a result, researchers, academics, and scientists, as well as the general public, have bought into a flawed understanding of how knowledge (epistemology) is made and how it evolves (evolutionary epistemology). Indeed, this bias toward EDs and RCTs is so complete that these two methodological approaches are often conflated as "science" whereas other methods are occasionally cast as "unscientific." EDs and RCTs are rightfully cherished, as they have many benefits such as: (1) the specificity of controls; and (2) the systematic avoidance of bias. But they hold just one position in the research and knowledge creation continuum. When one looks historically at how science has progressed, one cannot help but see a myriad of *seminal* examples of scientists (and science) who did not use ED and RCT methods, that nevertheless, contributed significantly to their discipline or to society's understanding of nature writ large. For example, if one were to seek out the proverbial "poster children" for science (literally, these are the folks who are posterized) they would find:

- Albert Einstein, who used thought experiments and abstract and theoretical mathematics;
- Jane Goodall, who pioneered the use of unorthodox methods of observation;
- Murray Gell-Mann, who correctly envisioned a new particle "with pencil and paper"(1); and
- Charles Darwin, who all but perfected the art and science of observation.

As such, the problem becomes how we conceptualize research design generally, a bias towards ED and RCT that therefore devalues the use and importance of a continuum of equally useful and impactful methods. In other words, the issue with research design isn't the methods used by these esteemed scientists, nor is it ED/RCT methodologies. The problem is that, as researchers, we often choose ED/RCT reflexively, even when it might not be the best choice for the job. The solution to this problem is placing ED/RCT in its proper context among other important methodological categories and ensuring that the *choice of methods* is related to the *condition of knowledge* being studied.

2. The Knowledge-Method Matching Matrix (K-MMM)

The Knowledge-Method Matching Matrix(2) or K-MMM, is a simple heuristic framework for making this relationship more clear so that it can be taken into account when choosing one's methods. To be clear, EDs and RCTs are relatively high on the methodological pecking order. A continuum of methods looks something like Figure 1.

[2]Address correspondence to E-mail: Derek Cabrera dac66@cornell.edu

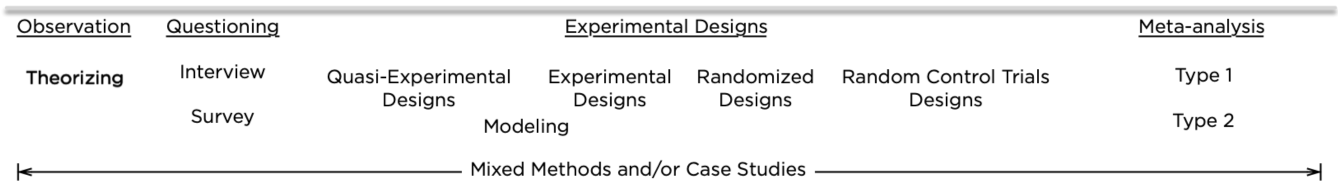

Fig. 1. X-axis of the Knowledge-Method Matching Matrix

The purpose of this paper is not to review the specific methods, techniques, and training for each of these methodological categories that lie along the X-axis continuum. There are countless resources available for learning best practices in, for example, survey research techniques. Instead, we hope to *situate* these methods in relation to each other and more importantly, in relation to the condition of knowledge under study. Situating these methods appropriately cause them to be seen as important and useful parts of a larger "research ecology." It is this *ecology of methods* that is the true catalyst in the creation and evolution of knowledge (a.k.a., science). It is important to note, that although it is common to mistake RCTs as the "gold standard"(3) of research, in actuality the gold standard is *meta-analysis*[*]. The reason for this is that meta-analysis takes into account an ecology of studies, using multiple methods, to determine if they collectively point to the same conclusion(s).

The Y-axis is also a continuum that ranges roughly from *Nascent* condition-of-knowledge to *Developing* to *Mature* (see Figure 2). When the condition of knowledge (about a specific phenomena, in a topical area, for a discipline, or for society and science as a whole) is low (Nascent), the types of methods that are best used fall on the left side of the X-axis continuum. As the condition of knowledge develops, the best methods move toward the right side of the X-axis.

Fig. 2. Y-axis of the Knowledge-Method matching Matrix

These two axes and the relationship between them are the underlying constructs of the K-MMM framework. The sole purpose of which is to remind the researcher to ***relate*** the *condition-of-knowledge* to the *choice-of-methods*.

[*] Meta-analysis often refers to an aggregate statistical analysis of multiple studies. We use it herein to include such studies but that could also include studies of various types to draw a common conclusion about a phenomenon of interest.

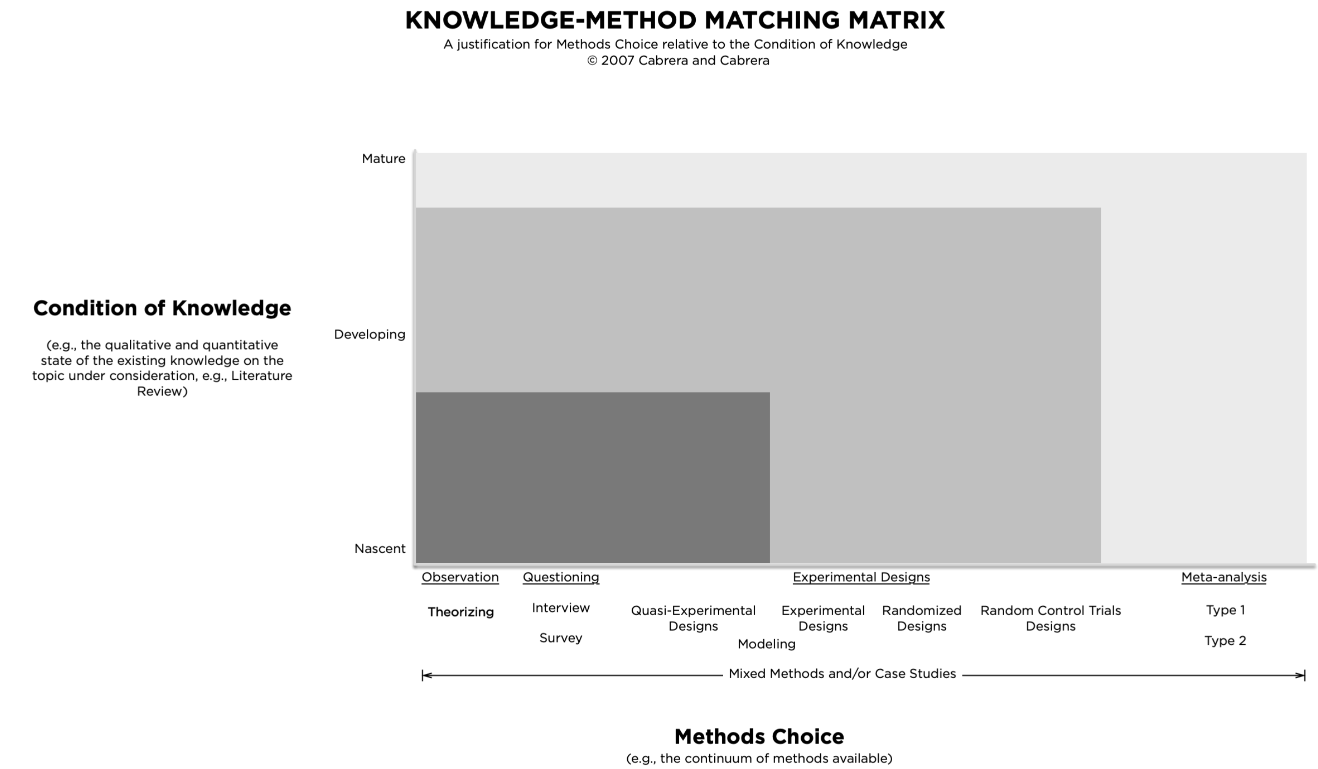

Fig. 3. The Knowledge-Method Matching Matrix

One might ask: if we want to understand some new phenomena, and our knowledge of it is very low (Nascent), but we can imagine the construction of an experimental design, why wouldn't we do that? To answer this question, one must understand what is needed to develop an experimental design, namely, clearly explicated variables. Yet, when knowledge is nascent, there is often disclarity about the salient variables. It should be noted that the *condition of knowledge* is a function of the *complexity of the phenomena*. For example, studying and/or understanding *empathy* as a variable is much more complex, and therefore difficult, than understanding a *fruit fly* as a variable. A fruit fly is inherently more tangible, explicit, isolatable, and "knowable." Empathy, on the other hand, is a messy variable that is hard to isolate and therefore has more construct validity threats. In order to design an experiment, one must use manipulation and controls to understand causality. Being able, for example, to isolate the dependent and independent variables so that one can control for them and measure their effects requires a fair degree of understanding of the topic of study. Imagine, for example, that an alien has just revealed itself on Earth. Having no knowledge of it, we are in the nascent phase. It would be ill advised to immediately set to task on an experiment, because we know so little, not even enough to devise a proper experimental question—to distinguish between dependent and independent variables, establish causality, or the means by which we might isolate said variables, control for them, or measure them. Rather than prematurely utilize an ED/RCT design, it would be smarter to simply observe (perhaps from a distance) until we learn something new. At that moment, the condition-of- knowledge incrementally increases. Such observation will help us to form a nascent mental model (heuristic) that can then be evolved as we gain more understanding. Only when this mental model becomes more clear can we begin to clearly identify the specific variables needed for a study with the sophistication of ED/RCT design. Until we gain enough clarity, we might choose to observe some more. Eventually, we might be ready to document case examples of our observations, or ask the alien questions (survey), or question others about it. As our knowledge of this alien phenomenon increases, we begin to consider quasi-experimental designs (N O X O) leading eventually to experimental designs where random assignment is used (R O X O) and RCTs that isolate a single outcome variable.

As knowledge of this new alien phenomenon expands, an inventory of this collective knowledge (i.e., a meta-analysis which might include many different observations, case studies, survey results, quasi-experimental and experimental and RCTs, using a mix of methods and approaches) may allow us to see common conclusions (friend or foe?) across the various studies. The gold standard of scientific research, meta-analysis, combines many studies, using many methods, to see if they all point to the same conclusion. This is how scientific *theory*[†] is established.

References.

1. G Johnson, Physicists recover from a summer's particle 'hangover'. *The New York Times* (2016).
2. LC Derek Cabrera, The Knowledge-Method matching matrix. (2006).
3. E Hariton, JJ Locascio, Randomised controlled trials - the gold standard for effectiveness research: Study design: randomised controlled trials. *BJOG* **125**, 1716 (2018).

[†] The term theory in science is the top of the food chain. This is counter to the view of the general public who think of scientific theories as "guesses" or what scientists might refer to as "hypothesis." Nevertheless, a scientific theory is synonymous with fact.