

What Is a Paradigm and How Can I Tell if I'm Swimming in One?

Engineering Education Research (EER), like research in many fields, centers on human subjects. As such, even when it is conducted by engineers and not social scientists, it exists in a social domain. When we shift our analytic focus from the physical to the social world, we must consider our assumptions about the nature of reality (ontology), the nature of knowledge (epistemology), and our perspectives on the credibility of various methodologies. Together these assumptions shed light on our entering research paradigms. According to Kuhn, scientific paradigms are "universally recognized scientific achievements that, for a time, provide model problems and solutions for a community of practitioners."¹ Kuhn's characterization of paradigms is conceptually helpful, but it fails to account for the concurrent diversity of models in engineering education research. Guba and Lincoln² have characterized paradigms as both competing and concurrent. They define a paradigm as "a set of basic beliefs with ultimates or first principles. It represents a worldview that defines, for its holder, the nature of the world, the individual's place in it, and the range of possible relationships to that world and its parts"(p.107).

You may be wondering why it is important to consider your personal worldview as an engineering education researcher. Here is a concrete example from my own research. During my undergraduate training in psychology, I was taught that the gold standard for social science research was experimental or quasi-experimental design. For my honour's thesis I used two experimental groups and one control group to examine judgements individuals make about personality. As part of the training for the experiment, research participants wrote a paragraph about the personalities of two individuals – me, and another student in the lab – who they had never met in-person. The research participants knew us only through our answers to a battery of questions on personality. In reading through the paragraphs, I found it interesting that almost all study participants thought I (cis-gender female) was male and my cis-gender male colleague was female simply because he was more emphatic than I was. I shared this finding with my supervisor who said, "great, tell me about your ANOVAs." This experience catalyzed my paradigm shift from positivism (my supervisor's paradigm, and the one I had been socialized to accept through my undergraduate education) to social constructivism. What my supervisor saw as interesting but not relevant to the analysis, I saw as a critical part of understanding the phenomena – we saw the same words, but had two different perceptions about the importance of the data.

I began to believe it was more important to analyze the full diversity of human interpretations of our experiences, than to test a small number of pre-set hypotheses about these experiences. Four years later, I began to see the power of critical theory to explain societal inequity. In both cases, my beliefs about the nature of social reality (ontology), and the nature of knowledge (epistemology) shifted in ways that impacted what I believe to be credible data.

Now it is your turn. **Table 1 below shows some of the distinctions between three (of many) competing paradigms** present in engineering education research—positivism, constructivism, and critical theory. Reflect on these three paradigms. Do you find yourself agreeing or disagreeing with the notion that research ought to be truthful, socially constructed, or transformative? Your ability to acknowledge and understand your assumptions about what constitutes credible research is more than a philosophical exercise. It enables you to optimize alignment between your research question, theoretical perspective, methodology, and methods.

It also allows you to communicate findings with those who swim in paradigms informed by competing assumptions. For more information on two paradigms commonly used in educational research, please see Guba and Lincoln's chapter on social constructivism,² and Kincheloe and McLaren's chapter on critical theory.³

Table 1: Ontological, Epistemological, and Methodological distinctions between Competing Paradigms

Paradigm	Positivism	Constructivism	Critical Theory
Purpose	Reveal truths about and relationships between social phenomena	Co-create social meaning in context from multiple perspectives	Reinterpret and transform inequitable social relations
Ontology	Realist (social facts exist independent of the observer)	Nominalist (universals exist only as concepts)	Dominant understandings of social phenomena are treated as real (reified)
Epistemology	Objectivity and neutrality are possible and desirable	Human understanding of social reality is always subjective	It is impossible to understand social reality independent of our social locations
Methodological goal	Nomothetic—explain social phenomena and the relationships between them in general terms (derive laws)	Ideographic—interpret the perspectives of actors in context	Examine patterns of privilege in society & unpack assumptions embedded in dominant policies, practices, and norms
Methods & Methodologies (examples)	Experimental design, randomized control trials, surveys (validated instruments), observation	Interviews, surveys (open ended), focus groups, ethnography, grounded theory	Critical discourse analysis, institutional ethnography, secondary analysis of survey data, critical auto-ethnography
Related theories (examples)	Post-positivism, logical empiricism, structural functionalism	Phenomenology, interpretivism, symbolic interactionism	Marxism, Critical Race Theory, Eco-feminism, queer theory, poststructuralism

1. Kuhn, T.S., *The structure of scientific revolutions*. 3rd ed. 1996, Chicago: University of Chicago Press.
2. Guba, E.G. and Y.S. Lincoln, *Competing paradigms in qualitative research*, in *Handbook of Qualitative Research*, N.K. Denzin and Y.S. Lincoln, Editors. 1994, Sage Publications: Thousand Oaks, CA. p. 105-117.
3. Kincheloe, J.L. and P. McLaren, *Rethinking critical theory and qualitative research*, in *Handbook of Qualitative Research*, N.K. Denzin and Y.S. Lincoln, Editors. 1994, Sage Publications: Thousand Oaks, CA. p. 138-157.

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