Guest Editorial

Confusions and Conventions: Qualitative Research in Engineering Education

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Introduction

Moving into a new area of research, especially an interdisciplinary area and from technical to social research data, can be daunting. There are many new terms to encounter and whole new ways of doing things. Furthermore, the new variety of qualitative research emerging from engineering education research groups can fall in betwixt and between – with reviewers from neither social science nor engineering domains recognizing what they see as quality and hence rejecting the work. As members of the Editorial Board, we have seen an increasing number of qualitative research papers submitted to the \textit{Journal of Engineering Education} over the last couple of years, but we are disturbed by the number of these that get rejected. How can we assess quality in unknown and innovative areas of work? This guest editorial aims to throw some light on the confusions arising at this juxtaposition of engineering/physical science and social science cultures in order to lay the foundations for better research papers and better reviews of qualitative studies in this \textit{Journal} and elsewhere.

In particular, we seek to highlight how research design encompasses epistemology, theory, methodology, and methods – all of them integrated in a coherent way.

What is the difference between theory and epistemology?

Often, engineers writing and reviewers critiquing in this new domain do not understand what epistemology is and how it differs from theory, yet it is important to understand and to articulate both within research studies. What theory is, what it looks like, and how it represents itself within research or the ensuing paper, can vary enormously, both within and between disciplines. We have heard engineers say that social scientists don’t have theory, just ideas, and we have heard social scientists bemoan the lack of any theoretical framing when engineers write. Nevertheless, we maintain that theory is similar across all domains – it is a way of thinking, a structure, a set of ideas, that have been written about in the past, have been around long enough to have hardy descendants (after Ravetz, 1996), and often have been published. This theory is then applied to the new work – either a new set of ideas, or “evidence” from data collected experimentally, or from literature. The theory might predict what we should expect – i.e., define for us our hypothesis – or it may take the form of a lens through which we analyse our current project, or both. Case (2008) has given a general introduction to the idea of theory in the social sciences, with some excellent exemplars.
Engineering theories arising from Western origins are often well established, tacitly understood, and attempt to predict the way the world works (for example, Newton’s laws of motion). They are placed within a particular epistemology, usually positivist, which claims that there is one truth about the world that we can discover. Social science theories, on the other hand, often embrace different ways of seeing the world and different epistemological positions. Epistemology, then, describes the assumptions we are making about the nature of knowledge and what counts as evidence, with the aim of formulating or refining scientific research questions. Within each epistemological position, there will be many different theories about learning, design, engineering practice, etc., but they all make sense within the particular way of knowing.

Two important epistemological positions are given below, excerpted from Willig (2001).

Positivism suggests that there is a straightforward relationship between the world (objects, events, phenomena) and our perception, and understanding, of it. Positivists believe that it is possible to describe what is ‘out there’ and to get it right. A positivist epistemology implies that the goal of research is to produce objective knowledge; that is, understanding that is impartial and unbiased, based on a view from ‘the outside’, without personal involvement or vested interests on the part of the researcher.

Social constructionism draws attention to the fact that human experience, including perception, is mediated historically, culturally and linguistically. That is, what we perceive and experience is never a direct reflection of environmental conditions but must be understood as a specific reading of these conditions. This does not mean that we can never really know anything; rather, it suggests that there are ‘knowledges’ rather than ‘knowledge’.

Commonly in engineering education work, engineers adopt a positivist epistemology because it feels more “rigorous,” sometimes without even being aware that they are doing so, even if they would not do so in their engineering work. However, many social scientists adopt the second epistemology, and sometimes this choice can cause difficulties when engineering academics get involved in social science-style research. It may be that an increased awareness of different epistemologies or even a shift in epistemological position is needed. To confuse ourselves even further, it should be noted that Willig here is talking about social constructionism, which is related to, but slightly different from social constructivism – an epistemological position often adopted by educational researchers. Roughly speaking, social constructionism refers to an understanding about the world as jointly “constructed” with other human beings – in other words, people with this epistemology believe that reality is socially constructed, not absolute as do positivists. Social constructivism, on the other hand, usually refers to the ways in which an individual constructs knowledge about the world in his or her social context. Both are interpretivist paradigms that acknowledge that human beings can interpret their surroundings; interpretivist paradigms recognize that social science data is often mediated through personal “stories,” and that facts and values cannot be separated.

To give an example of this difference in epistemological positions, we can look at the notion of student learning preferences. To a novice, the study of learning styles or study of learning approaches look remarkably similar, and, in fact to make matters worse, often the terms are used interchangeably or incorrectly. Furthermore, learning styles is a term used
by many different research traditions with differing epistemologies. In a positivist study of student learning using theories of learning styles, we assume that it is possible to objectively assign a learning style to a student which she has developed over time, and also objectively to determine the best possible teaching method to help her learn. In contrast, an interpretivist phenomenographic study of student learning would begin with the epistemological position that learning is negotiated between learner and instructor, and that for any particular social context, students will adopt a particular “approach” (Bowden & Marton, 1998). Research from this perspective requires us to adopt methods of inquiry where we explore experiences and perceptions with the aim of understanding how to assist students as a group to develop more useful approaches in their learning in particular contexts.

**What are method and methodology?**

Another common confusion in writing within engineering education is the use of the terms *method* and *methodology*. In engineering we use the terms interchangeably, but in qualitative education research, these terms can carry different meanings. Case and Light (2011) argue for “the value of using a broader definition of methodology, referring to a theoretical justification for the methods used in a study” (Case & Light, 2011 p. 187).

Thus, methodology is the philosophical justification for the research design and accompanying methods, while methods are the particular procedures used to collect and analyze data. Methodology, therefore, should contain the relationship between the underlying epistemology, theory, research question, and adopted method (Koro-Ljungberg & Douglas, 2008). Excellent exemplars of different qualitative research methodologies are given in Case and Light (2011). These include case study, grounded theory, ethnography, action research, phenomenography, discourse analysis, and narrative analysis.

Yet another source of confusion is that some terms are used for both a methodology and the epistemology that underlies that methodology. For novice researchers, this usage can create the problem of using the methodology as method, or a checklist of things to do, rather than understanding the philosophical assumptions that influence what can be known through that methodology. It is in fact even more complicated than this because different disciplines will use the same terms (such as discourse analysis) in different ways. Table 1 summarizes some of the more common epistemologies and methodologies that are used in qualitative research. There are, of course, others beyond those in this table.

**How is research design enacted in practice?**

In order to assist the reader to experience the variation (Bowden & Marton, 1998) of the critical issues in our discussion, we have chosen to focus on a very popular area of study in engineering education – that of engineering design. All of the articles discussed below might be considered design engineering education articles of one sort or another. But they differ greatly in their epistemological assumptions (which are largely unstated), their theoretical underpinnings (which are somewhat stated), their methodologies (which are generally stated), their methods (or lack of them), and their aims. Table 2 summarizes the articles we have selected as illustrative examples.

These articles take different epistemological stances, which in turn lead to different methodologies and methods. Most authors listed here are working within an interpretivist
framework, in which they understand human subjective experience to be many and varied. Phenomenography and constructivism live within this framework in slightly different ways – their underlying assumptions and related theories are not quite the same, as discussed by Booth (2004). Bucciarelli (1988) used the term ethnography as a methodology, not as an epistemology, and as a theoretical approach that understands design as a social process. Bucciarelli explicitly stated that design is a process that exists in the collective and that the various products created are artifacts of that process. This perspective informed his choice of ethnography that examined culture, which is created and maintained through shared practices and artifacts.

Kittleson and Southerland (2004) used discourse analysis as a methodology and set of methods within an interpretivist framework. Theoretically, they also considered design as a social process, but focused on the ways in which language (discourse) and nonverbal acts of communication (Discourse) produce knowledge. Thus, they used discourse analysis as a methodology to identify the ways in which the language used in a student design group influenced how students approached their project.

Daly, Adams, and Bodner (2012) began with the idea that engineers approach a design task in many different ways, and that understanding these different ways can help develop curricula by defining a variety of potential learning outcomes. With this perspective, they used phenomenography as their epistemology, theory of learning, and methodology with its associated methods to identify the variety of ways in which design can occur.

Atman, Chimka, Bursie, and Nachtmann (1999) examined the extent to which freshmen and seniors produce quality designs, and considered the elements of the design process that contribute to achieving quality. Although they did not state so explicitly in their

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<th>Table 1 Terms Used Dually as Both Epistemology and Methodology</th>
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<td><strong>As epistemology</strong></td>
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<tr>
<td>Discourse analysis</td>
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article, we consider this approach positivist because of the use of a standard that defines what makes a design of high quality, and their choice of analysis methods to create objective reliability. They focused on the theory of the design process and the specific elements of that process; these foci led to their use of verbal protocol analysis, which allowed them to capture the thought processes of the students as they occurred.

By questioning the dominant design discourse, Nieusma (2004) put forth an alternate conception that he proposed will “more adequately address the needs of marginalized social groups” (p. 23). His epistemology is inherently “critical” and therefore emancipatory – aiming for transformation in society. There is no “method” as such, and for the novice engineer entering the space of critical analysis, Nieusma’s article might seem to contain “no research except literature review.” However, deconstructions, descriptions, and critique are the methods of critical social theorists, who contribute to our knowledge and understanding of the social world, important research outcomes.

We take the view that none of these approaches is “right” or “wrong.” All of them are needed to gain a full understanding of the design process and its impact in a world made up of different people, cultures, and ways of being and knowing. Atman et al. (1999) help us to understand what factors affect students’ abilities to create designs that experts within the dominant discourse would recognize as high quality; Nieusma (2004) questions the notion of designing within the dominant paradigm; Bucciarelli (1988) and Kittleson and Southerland (2004) provide perspectives on how the social interactions in a design team act to affect the outcomes of the design process; and Daly, Adams, and Bodner (2012)

### Table 2 Examples of Articles that Examine Engineering Design with Different Epistemologies and Methodologies

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<th>Authors</th>
<th>Epistemology</th>
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<tr>
<td>Daly, Adams, &amp; Bodner (2012)</td>
<td>Interpretivist, phenomenography</td>
<td>Phenomenography</td>
<td>Individual interviews. Phenomenographic analysis to identify a hierarchy of different conceptions or ways of being and knowing.</td>
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<tr>
<td>Atman, Chimka, Bursic, &amp; Nachtmann (1999)</td>
<td>Empiricist, positivist</td>
<td>Verbal protocol analysis</td>
<td>Recording of students solving a design problem; quantification of parameters; statistical analysis of group differences and correlations.</td>
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provide us a means to understand the multitude of ways in which design is practiced and thereby to enhance the approaches that are more holistic and inclusive. Our understanding of the design process would be incomplete without these perspectives and many others we have not included. Just as there is no single correct way to understand a work of art, so too is there no single way to understand any aspect of engineering education.

**How do we move forward?**

This *Journal* seeks to publish more qualitative articles, particularly those that go beyond thematic analysis and that represent a diversity of epistemological views. Through this guest editorial, we hope to shed light on some of the issues that authors should be aware of to ensure their articles are of high quality. We have not touched on additional aspects to consider, such as approaches to ensure credibility and transferability. By considering the complete research design – to include the epistemological stance taken, the methodology and methods used, the role of theory, and the relationships among all of these – deeper, more transparent, and more nuanced analyses are possible. We also call on reviewers to recognize the perspectives that underlie qualitative research, for we have observed reviewers who reject qualitative papers because, for example, there are “not enough participants to generalize the findings.” By recognizing the different types of knowledge generated through interpretivist and critical epistemologies, reviewers can understand the role played by research that does not conform to positivist expectations. At the least, reviewers who are not comfortable or familiar with these alternate perspectives, methodologies, and theories should decline to review those papers. Ultimately, publication of research papers that come from diverse perspectives will make the resulting engineering education and engineering practice more democratic, open, and diverse.

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**References**


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