A Physicist's Reflection on Q Methodology, Quantum Mechanics & Stephenson

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I distinctly remember my first I4S (International Society for the Scientific Study of Subjectivity) conference in 2004. It was memorable for a number of reasons but one of the most vivid was finding out that Stephenson had been a PhD physicist as well as a PhD psychologist. Being a friend-tutored but otherwise self-taught Q methodologist, I hadn't bothered to learn much about the creator of Q yet. Others at the conference were excited to hear that I was a physicist like William Stephenson. Yet I didn't really sense the significance of this link between physics and Q until Steve Brown suggested I read some of Stephenson's many papers on Q and quantum mechanics. Just the suggestion of that link between Q and quantum mechanics made my brain start linking the similarities between the two.

I took to the task suggested and, at this point, I have read a number of Stephenson's works specifically discussing Q and quantum mechanics (Stephenson, 1982, 1983, 1987, 1988). I found Stephenson's 1988 paper to be the most interesting to me, even though it was written for the journal *Integrative Psychiatry*. The reason I felt especially drawn to this particular article had to do with Stephenson's linking of Q methodology, quantum mechanics, Newtonian physics and R factor analysis. I found it amazing that these interests from my professional life, as a physicist and education researcher, came together within this one article and I believe I grew in my understanding of Q by reading it.

I distinctly remember first learning about factor analysis, when I was a graduate student in education in an advanced statistics course. Factor analysis was taught predominantly as R but also as Q, P, and O factor analysis. I was immediately drawn by the parallel in terminology and ideas between quantum mechanics and factor analysis. Yet, I did not find any such parallel discussed, not surprisingly I suppose, until I read Stephenson, especially his 1982 paper (Stephenson, 1982). However, I think those similarities helped me immediately feel comfortable with R factor analysis because, as physics education research has shown, learners draw on their own prior experiences and knowledge when facing new ideas and learning experiences (Duit & Treagust, 1998, 2003). In turn, my prior experiences with R factor analysis and quantum mechanics enabled me, in part, to be

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relatively self-taught in the area of Q methodology. And it is these experiences that have led me to see R factor analysis and Q methodology as complimentary not in competition.

In my mind, R and Q can be compared much like Newtonian physics and quantum mechanics, which was substantiated through my Stephenson readings on Q and quantum mechanics (Stephenson, 1982, 1983, 1987, 1988). One does not preclude the other; instead, they each serve a distinct purpose, as described by Stephenson (Stephenson 1982). As Isadore Newman describes for research in the social sciences, methods selected are based on a typology of research purposes (Newman, Ridenour, Newman, & DeMarco, 2003). Newman et al. stress the importance of consistency among the research purpose and methods selected. It is the research purpose, they state, that dictates the methodology to be used in the study.

In terms of physics, quantum mechanics is relevant to the study of particles at the subatomic level whereas Newtonian physics applies to situations at the macroscopic level, as discussed in Stephenson's 1982 article (Stephenson, 1982). A physicist must understand the limits of classical physics, such as Newton's laws. In other words, a physicist would not use Newtonian physics to perform a study whose purpose is to solve a problem or question at the atomic level because quantum mechanics would be the appropriate method based on the purpose of the study. Similarly, R factor analysis and Q methodology address different purposes within social science research. Researchers must accept the obligation to make logical decisions not simply those based on mechanical considerations alone (Newman & Fraas, 1998). Although not a topic I found addressed by Stephenson, physics education research has addressed similar issues related to the problem solving and conceptual understanding of novice physics students (Harper, 2006; Leonard, et al., 1999; Mestre et al., 1993) and I wonder what Stephenson would have thought about such topics in conjunction with Q.

At a certain level, we can parallel R factor analysis with Newtonian physics, as Stephenson did (Stephenson, 1982, 1988). They each have purposes in research as well as limitations. For instance, researchers often use R factor analysis to estimate the validity of an instrument. In other words, the R factor structure may indicate the instrument is measuring what we intend to measure with it but it is not an absolute guarantee and, in addition, this validity estimate may only apply to a specific population.

There are theoretical considerations when using R to investigate instrument validity (scree plots, eigenvalue cut-offs, etc.) and these may or may not be described or even executed properly within the literature. My first semester physics students often demonstrate similar mechanical issues such as these during mathematical problem solving. In physics teaching, we often refer to students "turning the crank" in order to perform mathematical problem solving but with little to no understanding of the circumstances at hand but, instead, with a focus on getting an answer even if that answer does not make physical sense. I find many students focus on the answer instead of focusing on whether or not the means of getting the answer was appropriate with appropriate conditions selected. This same type of problem solving error can be seen in social science research including studies using R factor analysis and Q.

I will demonstrate by using an example that I believe demonstrates a case of researchers' conceptual misunderstandings of R factor analysis and the application of the scientific method. I have recently been working on an epistemology study using Q. While doing a literature review, I came upon a chapter in a book (Schraw, Bendixen, & Dunkle, 2002) that discussed the validity of a commonly used Likert scale epistemology survey by Schommer (Schommer, 1990). Schraw, Bendixen, and Dunkle "compared" the Schommer survey to one they created, the Epistemic Belief Inventory, by comparing the factor structure from R factor analysis of the two instruments using identical "conditions." Although there is nothing wrong with comparing different instruments' validity, issues with the application of this comparison were very apparent to me. First, the use of "identical conditions" exemplified a general misunderstanding of R factor analysis as the researchers attempted to apply a scientific method to their methodology. At the core of their process of comparison was that they used the same eigenvalue cut-off, 1, for both instruments. Yet such a decision represents a general misunderstanding about how eigenvalue cutoffs are determined in R factor analysis. Instead, it would seem these researchers accepted the SPSS default of an eigenvalue cut-off of 1 for both R factor analyses without additional considerations such as performing a scree plot. Although the eigenvalue cutoff of 1 appeared to produce an appropriate factor structure for the Epistemic Belief Inventory but not for the Schommer (Schommer 1990) survey, such results do not speak to the validity of the Schommer survey. Instead, the researchers should have further investigated why their results did not confirm those of Schommer (Schommer 1990). Although a reason for such differences includes using a different population for each study, such differences can also be explained by the differences in mechanical considerations, such as eigenvalue cut-off, for these two studies. Yet neither of these potential issues was discussed by Schraw et al. This is, in fact, very similar to the types of issues my novice Newtonian physics problem solvers face in my first semester of college physics classes although they are typically concerned if their final answer does not match the answer for those wonderful odd problems with answers are revealed in the back of the book.

As Mestre et al. (Mestre et al., 1993) confirm, physics students often see physics problem solving as a mechanical process and frequently lack problem skill and conceptual understanding. Singh (2005) discusses similar issues related to physics students understanding of problems in quantum mechanics. Thus, in physics education research, we are often seeking ways to get students to reflect on their answers and their conceptual framework whether it be in Newtonian or quantum physics. Stephenson certainly built such a process into Q methodology and I frequently wonder what he would have thought of the relatively knew field of physics education research (PER). Unfortunately, in physics and in R factor analysis, the researcher's position within the research has not routinely been made explicit. To me, it is important and appealing that Stephenson explicitly includes the researcher in decisions during the Q methodology process (Stephenson, 1955) yet developed a methodology that eliminates the need for reliability coefficients and estimates of validity due to the implicit nature of Q methodology and subjectivity research (Stephenson, 1988). The position of the researcher in Q is one of the reasons I see the centroid extraction with hand rotation such an important path within the Q methodology process. Although principle components and varimax make sense in the R factor analysis process, it is Stephenson's explicit inclusion of the researcher in the Q process that, I believe, makes hand rotation the most acceptable choice. I see hand rotation as best speaking to the subjectivity of any Q methodology study as repeatedly supported through Stephenson's writings such as *The Study of Behavior* (Stephenson, 1955).

It is also the subjectivity of Q that allows us to acknowledge that those performing the Q sort can better develop their views or even change their views as part of this measurement process. However, objective measurement such as having my students take a pre- and post-test using the Force and Motion Conceptual Evaluation (FMCE) does not result in the same type of effects as having those same students sort a Q sample. After completing the FMCE, students may ask me whether a particular answer they chose was correct but they don't seem to be changing their philosophical framework for conceptual understanding or how they think about learning. Something very different seems to happen during the Q epistemological study I have been conducting with these same students. A number of students have stated that doing the sort enabled them to reflect on and, in some cases, change their view of learning in our classroom. Such results warrant further study, which I will pursue, and they are at the heart, I think, of Q methodology and subjectivity. Just like quantum physics, the measurement affects the particle or person being measured. This is what separates Q from R factor analysis just as it separates quantum from Newtonian physics as discussed by Stephenson (1988). It is something to be celebrated and used appropriately to address a variety of research purposes.

Thus, Q offers social scientists a way to investigate subjectivity that expands the possibilities and purposes of our research. Yet, like physics problem solving, we must see Q as more than a mechanical process while developing our skill and conceptual understanding of this technique. I understand that the comparisons of Newtonian physics to R factor analysis and of quantum physics with Q methodology may be helpful to some yet not helpful to others for learning about Q even though Stephenson discussed these connections (Stephenson, 1982, 1983, 1987, 1988). In addition, I am not suggesting that such analogies might be helpful in getting Q studies published or even completed. Instead, I'd like to suggest that the most helpful concept from such analogies are based upon the idea of a typology of research purposes and how the purpose of a study dictates the appropriate technique to use whether a researcher is choosing a technique in physics or in social science research. As a physicist can see the clear distinction between Newtonian physics and quantum mechanics, we must demonstrate the clear distinction between a study with a purpose that leads to utilizing R factor analysis and one where the purpose leads us to Q methodology. This is, I believe, the overriding theme of Stephenson's 1988 article (Stephenson, 1988). In closing I will add that although Q methodologists do not necessarily need to understand quantum mechanics, it is often helpful to go back to the source of our method and read, or re-read, the many writings of William Stephenson. It certainly has been helpful for me and my understanding of Q methodology.

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