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Validity Threats in Modern Science: Why Social Science Research Methods Should be Compulsory for STEM Disciplines

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Abstract

The principles of research methodology were borrowed by social scientists from the natural sciences. However, research methods courses are more likely to be found in the social sciences today while the natural sciences take the principles of methodology for granted except in courses on laboratory methods in physics and chemistry or numeric methods in mathematics. This article suggests that it is time for the social sciences to serve as a model for the natural sciences by emphasizing the importance of teaching quantitative and qualitative research methods courses and adhering to the principles in research. The important principle of validity will be used to illustrate what modern physics, for example, could relearn from the social sciences.

Keywords: Research methods; Validity; Falsification; Measurement instruments; Social science; Physics

Introduction

When I was completing my doctoral dissertation at Edinburgh University, I once attended a gathering welcoming visiting Nigerian university Vice Chancellors to Scotland. I had the opportunity to introduce myself to a Scottish Physics professor who asked what I was doing and I said that I was doing research in law. He laughed and wondered how anyone could do 'research' in law. I laughed back and told him that I bet he did not teach his students research methodology whereas such courses are emphasized in the social sciences over and over again. He did not find that funny.

A student of the University of Lagos, Mr. Chibuihem Amalaha, recently announced to the news media that he has used a scientific experiment to prove that same-sex marriage is wrong [1]. His 'experiment' is the same kindergarten demonstration that most students observed with magnets which prove that opposites attract while sameness repels. From this he concluded that marriage is only for one man and one woman. This proved to be an embarrassment for his university and for Nigerian scholars who saw this as one more evidence of the poor quality of education in the country. I differ from the moral panic because I believe that what the young student was demonstrating with his imaginative mind is the same flaw in science education globally that I pointed out to the Physics professor in Scotland years ago. Any student who took social research methods classes would have known that the gay science student was using invalid instruments to measure marriage. It is a fact that marriage is between two people and not between two magnets. Instead of hounding the student into silence, his invalid instrument presents a teachable lesson for all science educators to consider making social research methods compulsory for science majors.

The natural sciences are so confident in their mastery of the principles of good research that they do not teach it as rigorously as is the case in the social sciences. They probably view the suggestion as ridiculous as offering courses to babies on how to walk upright. It is something you learn by trying and no amount of thick volumes of methodology textbooks would teach you how to set up experiments and observe the effects, record your observations and draw your conclusions under strict supervision by a master scientist.

This might be one of the reasons why Sandra Harding wrote that fascinating chapter on 'Why Physics is a bad Model for Physics' in her book, Whose Science, Whose Knowledge? Thinking from Women's Lives [2]. By some coincidence, the book was published about the same time that I had my encounter with the physics professor. It is obvious that the research education model in the natural sciences is more hierarchical than the collegial model found more commonly in the social sciences [3]. In the natural sciences, the professors serve more like guild masters and the graduate students serve more like apprentices who are allocated bits of tasks from a broader research program under the guild master. When the apprentice has learned to perform the tasks to the satisfaction of the master, the student is allowed to write up and submit for examination and possible award of a degree. In the social sciences, the supervisor needs not be working on a research program related to the student's research project. Sometimes, the student knows more about the topic than the supervisors. The supervisors provide advice but not instructions that have to be followed. Hence, the social sciences appear more democratic with multiple paradigms whereas physics is more hierarchical with one dominant paradigm at a time. For this reason, the model of paradigm shifts by Thomas Kuhn [4] is more appropriate to the natural sciences that were his exemplars than to the social sciences where multidisciplinarity and communities of interpretation are the norm rather than a single paradigm that conquers and dominates others until knocked off by an upstart anti-thesis.

I am not going to suggest that the social science model is better than the natural science model. Rather, I am submitting that both models are different and that the natural sciences could learn one or two things from the social sciences the way the founding fathers of the social sciences consciously tried to mimic and learn from the natural sciences. This is not entirely a new suggestion given that August Comte pointed out hundreds of years ago that biological sciences actually borrowed from the concepts of political economy especially with

reference to competitions between species and talks of the animal kingdom and plant kingdom, sexual reproduction in plants and of course, evolution [5]. I will illustrate the lesson that natural sciences could learn from social science methodology by looking at how both the refutations and confirmations of Einstein disregard the important principle of validity in their measurement and thereby commit flaws that would not be allowed in the social sciences.

Einstein, Validity and Modern Physics

Karl Pooper used Einstein's theory of gravity to illustrate the growth of scientific knowledge in general. He suggested that it is easier to confirm a theory by using it to explain things that happened in the past but more difficult for a theory to survive attempts to falsify it by testing its predictions. He said that Einstein survived this attempted refutation of his theory when Eddington's observation of an eclipse in 1919 proved the predictions of Einstein right. But he added that a good theory is always a falsifiable truth and so it is not surprising that scientists continue trying to falsify Einstein with some claiming to have refuted his theory or aspects of it while some claim that they have falsified the theory [6].

I will use two examples of researchers of African descent to illustrate this point. I have deliberately chosen these African scholars as my examples because I hope that they succeed in their tasks of making significant contributions to knowledge and thereby help to win more respect for African people. But whether or not they succeed, I am simply impressed that scholars of African descent are challenging major orthodoxies in science and my comments here should be seen by them as collegial constructive criticism to aid them and others in their ambitious tasks.

God Almighty Grand Unified Theory

GA Oyibo, the Nigerian Mathematician, claimed that he had discovered the 'Theory of Everything' which Einstein allegedly looked for but could not find. He claimed that his Grand Unified Theorem supplied the Fundamental Building Block of Quantum Theory in support of the ideas of Einstein. His critics say that he has correct mathematical formulae but that what he is claiming to have found remains to be proved. For instance, he claimed that the formula Gij,j = 0 proves that God Almighty is the power behind the universe and that a change in God equals zero because God is constant. He claims that he is able to unify the biblical story of the creation of Adam with the scientific theory of the Atom that emerged from the Big Bang which he interpreted as the word of God, and with an African story of creation according to which the waves from a waterfall, Atum, created the world. According to him, we can use his formula to solve any problem in the world from Aeronautics to healthcare, political corruption to genocide [7].

The simple question that a social scientist would ask here is whether Oyibo is measuring exactly what he said that he was measuring, the question of validity. If you measure someone's height and claim that you are measuring their weight, social scientists would observe that your measurement instrument faces huge validity threats. Oyibo may have succeeded in proving that when you spend all the money in your pockets to fuel your car at the gas station, your change would equal to zero (although using a credit card as is more common now challenges his premise) but that is not proof for the existence of God or Adam, Atom and Atum. His mathematical formulae read like poetry but he needs to address the validity threat by limiting himself to what he can measure instead of claiming to measure what is not measurable.

As one professor asked him during the filming of a documentary of his lecture tours of Nigerian universities, how can you claim to have captured God in one formula when God is believed by most to be beyond human knowledge, beyond measurement and beyond prediction? Oyibo's theorem would fall into what Popper would call dogma because he is claiming a truth that is not falsifiable, a truth about the nature of God that can only be accepted on the basis of faith and not on the basis of scientific facts. Perhaps his formula is just another name for God but it is not a proof of the existence of God, he may have calculated the amount of change in drivers' pockets but that is not the same thing as discovering Adam, Atom and Atum all at once. The problem here is the problem of validity of his measurement instrument, a problem that he never discussed, a problem that is rarely discussed in modern physics or mathematics.

The Invalidation of a Sacred Principle of Modern Physics

I was recently privileged to attend the inaugural lecture of Stephan J.G. Gift at the University of the West Indies, St. Augustine. I was puzzled by his idea that he proved Einstein's theory of relativity wrong and as I lay awake that night, I could not get his engaging lecture out of my head. I had to get up and read his paper published in Physics Essays that he circulated during the lecture. His argument was that Einstein's law of light propagation – that the speed of light in free space is constant and independent of the motion of the source or the observer – is wrong because his own experiments proved that light travels at variable speed [8].

I think that there is a validity threat to his experiments that he needs to reflect upon: Are you measuring exactly what you said that you wanted to measure – the speed of light (c) or are you measuring instead the time or frequency (v) with which the light reaches masses with different rates of velocity?

In the example or 'experiment' of the pedestrian, the car, the airplane and the rocket approaching a traffic light, was he measuring the speed of the light with c+ half c; c+600mph; etc. or was he measuring the speed with which the masses approach the light? It seems to me that the light remains constant in its speed of propagation while the different objects approach the light at variable speeds. Incidentally, while walking home from his lecture, I saw a big snail sluggishly crawling towards a street light while it took me a few strides to cover the same distance without affecting the speed of the light itself.

His second 'experiment' with Io and the earth again seems to measure the speed of Io relative to the earth and not the speed of light as such. For instance, was he saying that the sun shines in the tropics at a faster speed, no wonder the sun is so harsh there compared to North America and Europe. I think that it is more likely that the sunlight travels at the same speed but because the tropics are closer to the equator, it hits them hotter than those farther from the equator.

A different question is the applicability of the theory of variable light speeds. Does it imply that you could now develop lights that are faster than others instead of the more conventional one of lights that are brighter? What would a faster light do? Perhaps it would turn on the florescent tube faster, turn on the computer faster, propel airplanes faster? Just because his measurement instrument faces validity threats

does not mean that his insight could not be applied instrumentally in science fiction, for instance.

Conclusion

In conclusion, although I used two researchers of African descent to illustrate the problem of validity threats in modern science, it should not be assumed that the problem is only faced by scientists of African descent. A survey of Science Magazine articles will support my hunch that validity (measuring exactly what you said you are measuring) is confused with reliability (whether independent observations would replicate the results). For instance, an editorial in the Science Magazine argued that some new discoveries in science could not be 'validated' initially but the author was probably referring to reliability in the sense of replicability by future researchers [9]. Similarly, when a company sued a researcher and his college employers over the validity of test results, they were actually complaining that the results could not be independently replicated which is a question of reliability rather than validity [10]. The general public could be better educated about the concept of validity if the STEM disciplines would require their students to take and pass research methodology courses in the social sciences.

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