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Evolving Nature of Objectivity in the History of Science and its Implications for Science Education

Springer

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For Magda and Sabuhi

Preface

Like most science students I too was trained to understand that objectivity, certainty, truth, universality, and the scientific method were the five fundamental characteristics of both science and scientific progress. Despite all the reform efforts, science curricula and textbooks in most parts of the world continue to present science as a Baconian orgy of quantification. This inexorably leads students to believe that scientific progress depends on logically sound conclusions based on non-controversial experimental procedures. Considering that Kuhn's *The Structure of Scientific Revolutions* and Holton's *Introduction to Concepts and Theories in Physical Science* were published more than half a century ago, the present state of science education is all the more difficult to understand.

The relationship between objectivity, the scientific method, and inductivism had intrigued me for many years. About 6 years ago while teaching a course based on the role of history and philosophy of science (HPS) in teaching chemistry, one of the participating teachers expressed the following: "In contrast to the HPS perspective, the inductivist vision is rigid and does not contemplate "*transgressions* of objectivity." In other words, besides empirical evidence we need to situate progress in science within a historical, cultural, and philosophical milieu of the time. Considering that the idea of "transgression" was not discussed in class, I found this to be a very novel idea. Similarly, about 4 years ago while teaching a course related to the role of creativity in science, one of the participants provided a very creative response to the question: Was Newton objective in the formulation of his theory? In order to respond this participant first alluded to how Newton's vision was molded by the work of Brahe, Copernicus, Kepler, and Galileo and then went on to state that thanks to Newton, Einstein could go beyond. This led the participant to formulate another question: was Einstein objective and responded: for how long? This approach struck me as that of approximating to an evolving nature of objectivity within a historical context. This book is dedicated to these two students (and others like them) who shared their thoughts with me and provided the incentive to keep exploring the difficult concept of objectivity.

Next, I was influenced by Ronald Giere's critique of those scientists and philosophers of science who consider that what drives scientists onwards is that there

are *truths out there to be discovered*, and that such philosophical positions can be considered as "objectivist realism." Reading Lorraine Daston and Peter Galison's thesis of the evolving nature of objectivity within a historical perspective was a watershed event that provided me a sort of "eureka" experience. Their ideas eventually helped me to formulate the conceptual framework necessary for understanding objectivity in both science and science education. Roald Hoffmann's idea of "transgression of categorization" struck me as yet another way of approaching "transgression of objectivity" that in a sense facilitated a state of closure to my ideas on the subject. Furthermore, I found a common thread running through the ideas of Daston and Galison on the one hand and those of Hoffmann. Given the widespread use of objectivity–subjectivity dichotomy as almost a panacea, especially in science education, Glen Akenhead's suggestion that objectivity can be considered as an "opiate of the academic" seems plausible, and provided me with a new perspective.

It is important for me to have mentioned these experiences and how they helped me to understand objectivity and its evolving nature and thus provided the impetus for pursuing this subject for almost 10 years.

In writing this book, I did not have any particular course in mind. This has the advantage that the book could be adopted for various types of courses, such as teaching the nature of science, introduction to the history and philosophy of science, understanding the dynamics of scientific progress, and the evolving nature of objectivity. The intended audience for this book is secondary and university-level teachers, science teacher educators, researchers in science education, and graduate students.

Chapter 1 introduces the idea of "transgression of objectivity" and the evolving nature of objectivity within a historical perspective. A theoretical framework is presented in Chap. 2, based on Daston and Galison's (2007) ideas of truth-to-nature, mechanical objectivity, structural objectivity, and trained judgment. Understanding objectivity in research reported (1992–2014) in the journal *Science & Education* is the subject of Chap. 3. Next, Chap. 4 deals with understanding objectivity in research reported (1992–2015) in the *Journal of Research in Science Teaching*. Understanding objectivity in research reported in reference works related to science education is the subject of Chap. 5. The idea of science at a crossroads that is the relationship between transgression and objectivity in the context of nanotechnology is presented in Chap. 6. As a conclusion, Chap. 7 facilitates an understanding of the elusive nature of objectivity.

The following are some of the salient features of this book that can help readers to follow the line of argument developed in the different chapters:

1. A detailed account and evaluation (over a period of almost 25 years) of how the science education community conceptualizes objectivity.
2. Objectivity as a process and not a state, which can change/evolve continuously.
3. Objectivity and subjectivity can be considered as the two poles of a continuum.
4. The dualism between objectivity and subjectivity leads to a conflict in the evolving nature of objectivity.

5. Scientific facts are mute and hence need interpretation.
6. It is not the experimental data (Baconian orgy of quantification) but rather the diversity/plurality in a scientific discipline that contributes toward understanding objectivity.
7. Objectivity, certainty, truth, and infallibility as universal values of science may be challenged while studying controversies in their original historical context.
8. The scientific enterprise is characterized not by the scientific method, but rather controversies, alternative interpretations, ambiguity, uncertainty, and intuitiveness.
9. Open-mindedness and not relativity helps in understanding objectivity.
10. Reality presents a different perspective to different scientists and hence progress in science is based on narratives that generate tensions leading to "transgression of objectivity."
11. Polanyi's tacit knowledge represents trained judgment and logical positivism approximates to mechanical objectivity (based on the framework of Daston & Galison, 2007).
12. Scientists are probably less reflective of "tacit assumptions" that guide their reasoning than most other intellectuals of the modern age.
13. The tension between subjectivity and objectivity in assessment practices leads to the understanding that science involves interpretation (conceptual problems) and not just memorizing algorithms.
14. It is perhaps the contingent nature of science that manifests itself in the evolving nature of objectivity.
15. Scientific progress is at a crossroads due to the interaction between representation (passive measurement and observation) and presentation (intervention, active manipulation, nanotechnology).
16. Given the research reported in this book, science education is faced with the following dilemma: is objectivity an opiate of the academic?

Cumaná, Estado Sucre, Venezuela Mansoor Niaz

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