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BOOK REVIEW

Saxe, Geoffrey. B. (2012). *Cultural Development of Mathematical Ideas: Papua New Guinea Studies (Learning in Doing: Social, Cognitive and Computational Perspectives)*. Cambridge, England: Cambridge University Press. xxxiii + 362 pp. ISBN: 1107685699.

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In this essential work, Geoffrey B. Saxe brings to life the process of how humans use shifting representational forms in emerging cognitive functions across historical time. This is no small feat. There are many variables to track, and in the true sense of the word, the variables are changing. Saxe demonstrates, in beautiful detail, the power of the human mind to represent concepts, internalize and appropriate forms and functions, and engage in socially meaningful, coordinated action. Culture and cognition make each other up, and they shift, evolve, and change. Saxe's approach, steeped in ethnography, careful methods, and deep theory, provides a lengthy history and a careful description of how the development of mathematical ideas has happened over generations in one cultural community, the Oksapmin people of Papua New Guinea.

People all over the world have developed number and counting systems, and the Oksapmin case is particularly interesting. Some readers may be familiar with the body-part counting system, where one begins with the thumb on the right side of the body and continues across the body to the left hand. In this book, Saxe explains how the body-part counting system has changed and has been incorporated into new mathematical forms and functions that are attendant with cultural changes, especially shifts in economic exchange practices, as well as the availability of schooling and exposure to other languages and number systems in school.

Saxe is a master of theory and method in human development, and he provides a model for how to conduct contextually grounded, theoretically useful, path-breaking research that moves the field forward. Reading this book, one sees Saxe's thoughtful attachment to the Oksapmin people across three decades (1970s, 1980s, 2000s). Telling of his encounters in Oksapmin, Saxe brings the reader close to a world few outsiders have ever visited. Reading the book, it is clear how important Saxe's continuous ethnographic understanding is to exploring the processes being studied.

There is no one better prepared to conduct an ethnography of math and number understanding than Saxe, and the ethnographic report is quite good. He gives the reader the full picture of how he came upon his ideas and how he entered various settings with the help of certain relationships. This is important because the reader has the understanding that these relationships did not appear from nowhere. He also divulges concerns and struggles to achieve validity and lets the reader in on the challenges of fieldwork. In these descriptions, the reader sees how to go about such work, even in another setting and in other domains of knowledge and development.

Saxe provides a window into ontogenetic and sociogenetic functions that are naturally synchronic and diachronic but that are often operationalized as simply synchronic and individually ontogenetic or sociogenetic but not ontogenetic, thereby losing the capacity to illustrate processes of cultural change and the invention of cultural forms. When ontogenesis is left out, it is impossible to trace the diachronic trajectory of any phenomenon.

The first part of the book provides a solid introduction to relevant theories. Saxe outlines theoretical approaches to math and number development—why humans use numbers and how such use develops. Theoretical approaches to number development begin with the idea that cultural forms of number representation determine the numerical thought of individuals. Next is the evolutionary argument that cognitive structures are a result of hard wiring that humans developed over millennia. Finally, there is a synthesis of these—that cultural forms amplify what humans are naturally capable of. There is also the view of Piaget—that there is a genetic epistemology of number development and the child constructs number understandings in the mind through interacting with the world. As Saxe points out, these are all approaches that treat culture as independent from cognition. Through this book, he succeeds in demonstrating his theoretical-methodological approach as one that relates cognition and culture as processes that are intrinsically related to one another in the context of activities.

Parts II and III deal with changes in math and number as they are related to economic exchanges and to schooling, respectively. In a well-developed series of cross-sectional and longitudinal studies, Saxe strategically examines changes over time and their relationship with changes in mathematical understandings. Interestingly, the long period across which Saxe worked in Oksapmin has seen the greatest expansion in economic exchanges—different kinds of money were introduced, and there were changes in currency. There were also changes in schooling and increases in the availability of goods. Most compellingly, there was uniformity and variation in several discrete periods of time and continuity and discontinuity across longitudinal time. The story of change presented is a most complete and thoughtful one because of attention to multiple variables at multiple levels of analysis.

Part III explores schooling and cognitive change by examining the historical record, ethnographic and task-based observations and interviews, and classroom observations related to number. All of this is done synchronically and diachronically. Changes and shifts in schooling and the forms and functions related to number representation—such as multiple languages and writing systems used in school—are related to different ways of understanding cognitive representation of specific local forms, such as string bags; the development of cognition is independent of the particular cultural forms used in measurement.

Part IV integrates the findings in the book and examines what develops in mathematical thinking, how development occurs in form–function relations in collective practices across time (synchronic and diachronic), and why development occurs—what are the regulative processes in microgenesis, sociogenesis, and ontogenesis in form–function relations in collective practices?

The book—a winner of the Cognitive Development Society Book Award—is a major contribution because it succeeds in showing how shifting practices can be examined to illustrate the interplay between microgenetic, sociogenetic, and ontogenetic processes when we are willing to look at them closely over time. It will be useful to those who work in other communities and cultural settings and in other domains of knowledge and practice. This tome of knowledge—lengthy, but succinctly presented—will endure as a classic explication of culture–cognition relations.