Humanistic Mathematics Network Journal

Issue 7 Article 13

4-1-1992

Mathematics From an English Major's Point of View

Elizabeth Miller
Richard A. Henson School of Science and Technology

Kathleen M. Shannon
Richard A. Henson School of Science and Technology

"MATHEMATICS - FROM AN ENGLISH MAJOR'S POINT OF VIEW"

Elizabeth Miller

The following paper was written by a Sophmore English major, Elizabeth Miller, in my Mathematics and Culture class last fall. I was intrigued by her view of mathematics and thought that the paper would be of interest to other members of the Humanistic Mathematics Network.

The class of which Ms. Miller was a member involved discussions of and readings about mathematics. It was a somewhat successful attempt to show students who generally avoid mathematics some of the beauty and diversity of the subject. It used The Mathematical Experience by Davis and Hersh, Adventures of a Mathematician by Stan Ulam, and The Fourth Dimension by Rudy Rucker as its major texts. I offer one or two sections of the course every semester.

The term paper assignment for the course was deliberately open ended, leaving the choice of topic entirely up to the individual student. Most students write about one of a list of suggested topics or about a particular mathematician or physicist. Ms. Miller's choice of topic was much more original as was her treatment of it. Enjoy.

Sincerely,

Kathleen M. Shannon
Department of Mathematical Sciences
Richard A. Henson School of Science & Technology
Salisbury, Maryland 21801-6837

THE NATURE OF MATHEMATICS

For the duration of this semester in a mathematics and culture class, I have been learning how mathematics affects and is affected by cultures of the world. Now I would like to explore the concept of mathematics as a cultural system or a subculture in and of itself, its subsequent evolution, and the multiple characteristics thereof. The nature of the subject of mathematics is generally misunderstood, though every civilization uses mathematics to some extent. Even among professional mathematicians, opinions regarding the nature of mathematics and its relationships to other aspects of culture vary greatly. These opinions can include elements of mysticism, practical utility, logic, and Platonism. Mathematics is more than a method, an art, or a language; it is a body of knowledge that serves the physical and social sciences and the fields of theology, art, and philosophy.

MATHEMATICS AS A SUBCULTURE

Mathematics has not always been considered a subculture; for example, the mathematics of the Babylonians and the Egyptians merely warranted the status of a "cultural element." The question of when the status changed format from that of cultural element to subculture has not been addressed extensively by anthropologists, but the criteria for the transformation includes 1) a unique set of traditions within the traditions of the general culture 2) laws of development and 3) the fact that it is cumulative, so as a result, it evolves (Wilder, <u>Mathematics</u> 13). Mathematics as a subculture can be thought of as a

system of vectors with each vector striving for growth. Different vectors impinge upon one another, diffuse, and affect others, sometimes resulting in new consolidations and new vectors. Each vector generates its own stress or force, but at the same time, it is subjected to external stress both from other vectors and from the outside culture. Thinking of mathematics as a cultural system offers a means of explaining anomalies not satisfactorily explained by philosophical or psychological methods. Culture consists of a general collection of beliefs and prejudices and the knowledge required to do the job; it is not invented or discovered, but acquired through the processes of communication. The culture of a group consists of the sum of the individual world views united by the bonds of communication.

MOTIVES OF CHANGE

Before discussing the evolution of mathematics, I think it would be appropriate to illustrate some of the motives that produced the changes. The most obvious motive for the evolution of mathematics involves social needs, i.e.: the development of calendars, commercial and financial transactions, navigation, the construction of buildings, and the design of weapons of warfare. An equally significant motive has been to provide rational organization of natural phenomena. The concepts, methods, and conclusions of mathematics contribute to the foundations of the physical sciences. The success of these fields has been dependent on the extent to which they have entered into a sound partnership with mathematics.

These aforementioned motives are completely valid, but it is a mistake to assume that mathematics is stimulated by practical considerations only. Some mathematicians have these practical considerations in mind while pursuing their ideas, while some remain totally indifferent to pragmatics. For instance, much of the mathematical knowledge pursued by the Polish mathematician Stanislaw M. Ulam was practically applied (Ulam). In contrast, it is possible to say also that the idealistic contemplation of Pythagoras and Plato have yielded more significant contributions than those provoked by purposeful acts. The field of mathematics has been molded by practical, scientific, aesthetic, and philosophical interests alike, so it would be impossible to separate the influences and contributions of any one of these forces and compare it to the others.

The drive to create is often inspired by the search for beauty. Aesthetic satisfaction can be achieved through the indispensable use of imagination and intuition incorporated in the creation of proofs and theories. If it is true that insight and imagination, symmetry and proportion, and the exact adoption of means to ends are comprehended in beauty and are characteristic of works of art, then it can be said that mathematics is art with a beauty of its own.

EVOLUTION OF A SUBCULTURE

Throughout the history of the evolution of mathematics, there exist certain identifiable stresses or forces that figure prominently in the development of the field. Environmental stress, diffusion, cultural lag and resistance, symbolic language, and selection all affect the evolution of mathematics. The idea of evolution of a subculture did not arise from the field of biology, but from that of sociology, namely through the work of Herbert Spencer (Wilder, Mathematics 20). It is also very important to establish the fact that the term "evolution" should not be confused with the term "history." History is a generalizing process and can be thought of as a "record of past events arranged in chronological order with some discussion of relations between events (Wilder, Mathematics 18)." Evolution on the other hand can be considered as a "process of change by which various forms and structures change into 'improved' forms and structures and are generally motivated by certain forces whose nature is dependent upon types of forms or structures involved (Wilder, Mathematics 18)." It is necessary to deal with the evolution of concepts as well as the history and evolution of mathematics as a cultural entity.

ENVIRONMENTAL STRESS

As in the case of most subcultures, mathematics has been subjected throughout its history to influences from the environment and virtually owes its existence to the necessities of culture. Allow me to site some examples. Counting and measuring systems arise in each culture as it advances. The Greek word "geometry" literally means "earth measure" and therefore displays its social origins (Wilder, Mathematics 54). For the Babylonians, geometry had no status as a social discipline; it served more as an accessory to arithmetic. Its function seemed to be predominantly as a compendium of formulae for calculating lengths and areas, thus satisfying a social need. For the Greeks however, geometry became a full-fledged discipline, the development of which was influenced by philosophy and astronomy. Originators include Eudoxus, an astronomer, and Parmenides and Zeno, two philosophers whose influences apparently contributed in large part to the consolidation of logic with mathematics.

Though the general feeling may be that mathematics has become more self-sufficient and less dependent in modern times upon environmental stresses for its concepts, it is true that such stresses continue to exercise influence on the development of the field. During World War II, mathematics initiated the invention of more efficient computers and accompanying theories, pursuits in operations and systems analysis, not to mention new developments in already established fields. Adventures of a Mathematician, the autobiography of Stanislaw M. Ulam, gives an in-depth account of Ulam's involvement with the construction of the hydrogen bomb. In fact, he co-authored with C.J. Everett the paper that supplied the foundation for the creation of the bomb. It appears that environmental stress and its affects on the field of mathematics function in a cyclical fashion; environmental stress yields the need for advanced or different mathematical theories which in turn give way to original environmental applications that result in new environmental stresses. An appreciation of the impact of culture upon the mathematician and his work can make significant and beneficial contributions to the profession. Knowledge of cultural influence substitutes for otherwise vague intuitions and can influence problem choice and attitudes towards the work of fellow mathematicians.

DIFFUSION

The process of diffusion also plays an integral role in the evolution of mathematics. Diffusion can be defined as cultural elements passing from one culture to another. A basic pattern of diffusion is as follows: from Babylon and Egypt to Greece and India to Arabia to western Europe (Wilder, Mathematics 48). Arithmetic, geometry, and elementary algebra in a primitive form were involved in this schema. It was the diffusion from India to Arabia that brought about the term "Hindu-Arabic" assigned to the modern numerals (Wilder, Mathematics 48). This process of diffusion is particularly evident where traders or missionaries intervened. "The Ascent of Man-Music of the Spheres" also points out the aid of the Islamic and Christian religions in the diffusion of mathematics.

Without the diffusion of mathematical methods and concepts to the natural sciences, our modern technological culture would not exist. However, there is a trade-off in that as mathematics has contributed to the advancement of other fields, those fields have influenced mathematics, by suggesting models for analysis, for example. Geographic diffusion is no more important than diffusion among fields such as mathematics and the natural sciences. Consider the history of logic. "Discovered" by the Greek philosophers, logic penetrated Greek mathematics early through the axiomatic method; Euclid's "Elements" are upheld as the prime example of logical deduction. In both philosophy and mathematics, logic passed through medieval phases until

De Morgan and Boole developed it into higher symbolic mathematical logic which in the 20th Century, is its own field.

CULTURAL LAG AND RESISTANCE

As is true in every cultural system, a degree of cultural lag or cultural resistance is inevitable. Cultural lag is the "failure of a culture to adopt or adapt to innovation" which is similar to procrastination or conservatism on the individual level. When the refusal to adopt an invention is more overt, cultural lag is more aptly designated cultural resistance (Wilder, Mathematics 25). While these terms appear to connote negativism, cultural lag and resistance do have a certain survival value, because they can denote cultural stability. The development of the numeral system, also known as the method of counting, is a good example of cultural lag. Ionic numerals, letters of the Greek alphabet augmented by three archaic letters with modifying symbols, were easy to use and sufficient for ordinary calculations. They persisted until the 15th Century, though place value numerals of the Babylonians and the Hindu-Arabic numerals were known. The Roman numeral system, though clumsy, survived past the Roman Empire. Newton's calculus symbols known as "dotage" persisted in England, though Europe adopted Leibnizian notation which was operationally more effective. Thus, cultural resistance was due to national pride. Cultural resistance has also kept the United States from converting to the Metric System.

THE SYMBOLIC LANGUAGE

Another important characteristic of mathematics is its symbolic language. Mathematics expresses quantitative relations and spatial forms symbolically. Unlike the usual language of discourse, which is a product of custom and social and political movements, the language of mathematics is carefully and purposefully designed. Because of its compactness, it permits the mind to deal with ideas which, if expressed in ordinary language, would be unwieldy and conducive to inefficiency of thought. However, the specialized symbolic language does create its own problems. The mathematical language is precise and often confusing, thus making it harder for those unaccustomed to its form to follow any sort of mathematical discussion. However, exact mathematical thinking and exact language do go together.

As cultures advance, so do their linguistics and numeral systems. Every culture seems to have yielded to the necessity of counting. Symbols in various tally forms sufficed for primitive cultures, but eventually gave way to number-words. The evolution of mathematical symbols is marked by three significant achievements including cipherization, the concept of place-value, and the invention of the zero. "Cipherization," attributed to C.B. Boyer, is the invention of efficient symbols for individual digits. The Hindu-Arabic digits represent the peak of cipherization in western culture. "Place value" is the assignment of a value to a digit according to its position. The invention of the zero is the direct result of the need for a device to indicate the idea of "no value." Prior to this invention, early Babylonians were forced to guess values by context. (Wilder, Mathematics 50)

SELECTION

Selection is inextricably associated with the evolution of mathematics and involves the choices governing such things as ciphers, bases, theories, and symbols. Mathematical selection is not necessarily equivalent to the natural selection associated with the natural sciences and Darwin's theory of survival of the fittest. In the field of mathematics, this criterion applies only to some selections. Selection on a global basis has usually been a cultural process including both individual and cultural choice. The reasons for selection differ from one case to another. While selection of a general theory may at first be primarily influenced by the eminence of the author and the status of the institution with which he or she is associated, its survival in the long run is

more dependent upon its mathematical significance. Its usefulness and especially its ability to further the development of mathematics will often determine its persistence throughout the evolution of mathematics.

ABSTRACTION AS AN INEVITABLE FUTURE

By examining characteristics of culture which include evolution, environmental stress, diffusion, cultural lag and resistance, language, and selection and applying these characteristics to the field of mathematics, it is possible to perceive mathematics as a cultural system or a subculture in and of itself. Mathematics as a subculture is inherently subject to evolution through relentless study, philosophical discussion, and pragmatic application. As a cultural system like that of mathematics grows, evolves, and becomes institutionalized, increased abstraction inevitably results. This occurs within the structure of every culture and is not restricted to scientific systems. In the field of religion, abstract theologies augment the original simple rules and rituals in an effort to meet the demands of a society growing in complexity. Individuals and their cultures will continue to evolve, as will the subculture of mathematics. Mathematical innovations will persist in broadening cultural perspectives and influencing such seemingly unrelated fields as philosophy, theology, and art. It is through this mathematical abstraction of special fields that the promotion of other fields is made possible.

BIBLIOGRAPHY

Kline, Morris. Mathematics in Western Culture. First ed.
New York: Oxford University Press, 1953.

Ulam, Stanislaw M. Adventures of a Mathematician. First ed.
New York: Charles Scribner's Sons, 1976.

Wilder, Raymond L. Mathematics as a Cultural System. First ed.
Oxford: Pergamon Press, 1981.

Evolution of Mathematical Concepts. First ed.
New York: John Wiley and Sons, Inc., 1968.