Caleb Gattegno:
A famous mathematics educator from Africa[*]

Arthur B. Powell
Department of Urban Education
Rutgers University–Newark, USA
abpowell@andromeda.rutgers.edu

Caleb Gattegno (1911-88), son of a Spanish merchant, was born and grew up in Alexandria, Egypt. Later, he lived in Cairo, Egypt; in London and Reading, England; Addis Ababa, Ethiopia; in La Chaux de Fond, Switzerland; and in New York City, USA but worked all over the world, in all continents. His social concerns and intellectual development as well as his research into mathematics, mathematics education, linguistics, and psychology began in Africa, a continent to which he made several significant contributions. He was eighth of nine children, had to work for his living from an early age, but always sought to learn and become educated. He committed himself to study, read whatever came his way, particularly mathematics texts, and often earned money by tutoring others. In 1929, at the age of 18, he earned a bachelor of science degree. Between the ages of 20 and 25, studying on his own, he took external examinations in Cairo and obtained teaching licenses in chemistry and physics (1931), in mathematics (1932), and an advanced studies diploma in mathematics in (1936), all from the University of Marseilles, France. He was a self-taught mathematician whose independent studies led him to from the and a doctorate in 1937 from Basle University, in Switzerland (thesis title: *Les cas essentiellement géodésiques des équations de Hamilton-Jacobi intégrables par séparation des variables*[1]).

---

[*] I am grateful to Marilyn Frankenstein, Shakti Gattegno, Paulus Gerdes, Dick Tahta, and David Wheeler for their critical review of an earlier version.

[1] Translation: The essentially geodesic cases of Hamilton-Jacobi equations integrable by the separation of variables.

11/22/04 Draft: For publication in *AMUCHMA Newsletter* (a periodical of the African Mathematical Union's Commission on the History of Mathematics in Africa).

In 1932, he founded the Mathematics Seminar, Alexandria's first, modern university-level courses in mathematics. From 1937 to 1945, he founded and directed the Institute of Advanced Scientific Studies in Cairo, a center for students not eligible for higher degree, university courses, and published papers on mathematics and education. Between 1957 and 1958, while working in Ethiopia for UNESCO, he produced textbooks and new teaching materials. Notably, he developed an extraordinary method of teaching the reading and writing of Amharic, by color coding its phonemes and arranging them on charts. Being an accomplished linguist who spoke and worked in several African and European languages, he prepared color-coded charts for most major languages, besides Amharic, including Arabic, Mandarin, English, French, Hindi, Portuguese, and Spanish and developed powerful approaches to the teaching of native language literacy and of foreign languages, which he called *Words in Color* and the *Silent Way*, respectively.[2]

From his early days in Alexandria, Gattegno embarked on a life-long study of human learning, not just in the field of mathematics. An examination of the titles of articles he published while teaching in Cairo reveals that Gattegno sought to understand how social condition as well as psychology influence learning. His psychological investigations concerned the dynamics of the mind and the role of awareness in learning, *conscience de la conscience*.[3] He pursued

[2] A discussion of *Words in Color* and the *Silent Way* lie outside the purpose of this paper. Interested readers may consult Gattegno (1976 and 1985a); and from the viewpoint of practitioners of *Words in Color*, see the special issue of *The Science of Education in Questions*, 15, which may be obtained from William Bernhardt, Association for the Science of Education, PO Box 11, Mahopac, NY 10542, USA; or email <bernhardt@postbox.csi.cuny.edu>. For *La Science de L'Education en Questions*, 15, in French, write to Une Ecole pour Demain, Cidex 26 bis, Route du Village, 25720 Larnod, France.

[3] Translation: awareness of awareness.

these inquiries and, along the way in 1952, earned a second doctorate, this time in psychology from Université de Lille, in France.

Just after the end of World War II, Gattegno moved from Africa to Europe. In England, feeling as an outsider, he organized seminars for displaced people out of a desire to meet and help them. There he became a lecturer in mathematics at Liverpool University and later at the Institute of Education, University of London. During this time, he continued to inspire people and founded several other organizations: in 1947, L'Ecole Normale Internationale, meetings of educators, professors, and adolescents to investigate the role of education in maintaining world peace, for which he was its unpaid director until 1957; in 1950, the International Commission for the Study and Improvement of the Teaching of Mathematics (CIEAEM) and was its secretary until 1960; and both in 1952, the Belgian Association of Teachers of Mathematics and, in England, the Association for Teaching Aids in Mathematics (now the Association of Teachers of Mathematics) and served as the first editor of its journal, *Mathematics Teaching*.

During his London days and throughout his life, Gattegno persisted with his African praxis: social action combined with research and material development. He was an early English translator of Piaget (1949, *Play, Dreams & Imitations* and 1951, *The Child's Conception of Number*[4]) and influential in spreading knowledge of developmental psychology. After 1949, he acquainted teachers with the silent, unlabelled, and animated geometric films of Jean-Louis Nicolet, a

[4] While translating from French to English, *The Child's Conception of Number*, Gattegno states that he "had opportunities of getting stuck at a number of points" and "suggested to Piaget that Part II of the published study must be different if he wanted the book published in English with [Gattegno] as the responsible translator. [Piaget] yielded…and the English translation differs considerably from the original French" (1983, p. 6).

Swiss secondary-school teacher, as well as of his own, and demonstrated how films of the Nicolet genre provide a dynamic approach to geometry in classrooms. He invented geoboards (1952) and incorporated them into his dynamic approach for teaching geometry. In 1956 and again in 1958, based on symposia of the CIEAEM, he edited respectively volumes I and II of *L'Enseignement des Mathématiques*,[5] among the contributors to both volumes, besides Gattegno himself, were J. Piaget, G. Choquet, and J. Dieudonné.

In 1953, Gattegno became acquainted with the ingenious work of Georges Cuisenaire, a Belgian schoolmaster, who invented handpainted *réglettes*, wooden colored rods, to teach his students arithmetic. Struck by the pedagogical power and mathematical potential of Cuisenaire's rods and book, *Nombres en Couleurs*,[6] Gattegno introduced teachers to Cuisenaire's work, applied the use of his rods to teaching higher levels of mathematics, elaborated text materials in several languages for use with Cuisenaire rods, extended the underlying color coding of the rods[7] to a rich variety of rectangular solids and prisms (1956), and traveled around the world eight times, visiting over forty countries, lecturing on the use of Cuisenaire rods and Gattegno's own epistemological and pedagogical approach to the teaching of mathematics. These activities brought him back to Africa. In 1958, commenting on official attempts to implement his pedagogy and

[5] Translation: The Teaching of Mathematics.
[6] Translation: Numbers in Color.
[7] Cuisenaire imbued the rods with functional and interesting correspondences between color and length. Rods of the same color are the same length and, conversely, rods of the same length have the same color. A length that is the double of another is also darker in tone. The smallest rod is a neutral color, usually referred to as "white." Rods that are equivalent in length to two, four, and eight white rods have pigments with an affinity to the red family (purple and brown). Rods equivalent in length to 3, 6, and 9 white rods are colored respectively light green, dark green, and blue; while rods equivalent to 5 and 10 white rods are yellow and orange. The rod whose length has the distinction of being relatively prime to rods of all other lengths in

verify his claims, Gattegno reports that, besides countries in Europe and the Americas, his work had drawn the attention of educators in Africa: "South Africa, the Rhodesias, Central and Eastern African states have been experimenting on a scale which speaks highly of the enthusiasm of local teachers and administrators" (1960, p. 7).[8]

Through his worldwide efforts between 1953 and 1962, traveling approximately eight times around the planet, Gattegno founded eleven Cuisenaire companies to distribute rods and his own text materials as well as to work with teachers. Through the educational activities of the Cuisenaire companies as well as his lectures, workshops, and books, he helped many thousands of teachers all over the world realize that Cuisenaire rods offer insights into spatial relations underlying arithmetic and that the rods model the *algebra* of the rational number system or, more abstractly, a *commutative field*. He advocated that teachers allow students to encounter *algebra before arithmetic* as they explore the rods as objects embodying implicit mathematical relations.

By 1965, Gattegno had moved to New York City, where he founded Schools for the Future and later established an educational laboratory, Educational Solutions, Inc.[9] Through both organizations and with the assistance of teacher educators who worked for him, he disseminated his educational materials, trained thousands of teachers, and worked in hundreds of schools all

---

the set is colored black. Later, the functional and pedagogical use of color influenced Gattegno's literacy materials that he first developed in Ethiopia.

[8] At the London Institute of Education, Gattegno taught a diversity of African students from the British colonies. After contact with his ideas, some students would return home and attempt to implement them. Such is how experiments occurred in places like South Africa. Though invited, he refused to visit the Republic of South Africa, owing to its then policy of Apartheid.

[9] Readers interested in obtaining Gattegno's publications and educational products should address inquires to Educational Solutions, Inc., 99 University Place, New York, NY 10003-4555, USA; or telephone 212/674-2988.

over the USA, including, in particular, special projects with teachers and schools in the African American communities of Harlem and the South Bronx of New York City and in southern cities of the United States, many at the time just emerging from decades of strict racial segregation. Furthermore, from his base in New York City, he continued to travel worldwide, to give seminars and workshops, to research, to develop new materials, and to write.

Gattegno wrote many important articles and books on mathematics teaching, including *For the Teaching of Mathematics* (1963, three volumes), Functioning as a Mathematician (1967), *The Common Sense of Teaching Mathematics* (1974), The Foundations of Geometry (1980), Curriculum and Epistemology (1984a), Curriculum and Epistemology II (1984b), and Reflections on Forty Years of Work on Mathematics Teaching (1988b). He developed films for teaching trigonometry;[10] computer-animated films for teaching geometry, synthesizing and extending some themes of Nicolet's films[11] and initiating some of his own;[12] and created an innovative microcomputer software, incorporating ideas of equivalence, complementarity, and transformation to teach numeration, addition, and subtraction.[13]

Importantly, Gattegno posited perception and action as bases for mathematical thought and mathematics as the study of the dynamics of relationships *per se*. He developed classroom materials and pedagogical approaches that invite learners to engage their powers of perception and action to mathematize situations and, thereby, become aware of their own mathematical ideas as they make explicit their awareness of relationships implicit

[10] Produced in the 1960s, *Folklore of Mathematics*, and available from Educational Solutions.
[11] 1981, *Animated Geometry*, New York: Educational Solutions.
[12] 1979, *Foundations of Geometry*, New York: Educational Solutions.

in these situations.[14] He argued that teachers should "use the time in class to make students mathematize situations and discover how many chapters of mathematics can be deduced, induced, from a minimum of givens" (1984b, p. 21). Referring to this latter notion, he coined the phrase *a lot from a little*, which as he explained means "'[g]ive students only what they cannot reasonably find by themselves and let them do the rest'" (1984b, p. 21). Furthermore, except for "what they cannot reasonably find by themselves" such as labels and terms, Gattegno's pedagogical approach does not require students to memorize facts and algorithms. Instead, he understood that "mathematization is not only accompanied by the joy of discovery but also by functional retention" (1988c, p. 132). These annotations point to a few elements of his practical epistemology that he called *the subordination of teaching to learning*. However, the annotations barely scratch the surface of his thinking. A succinct, thought-provoking summary of his life's work in mathematics education is found in his book, published posthumously, *The Science of Education, Part II: The Awareness of Mathematization* (1988c).

Who was Caleb Gattegno? This question is difficult, even impossible to answer especially since, here, we focused on only a few aspects of the man. Nevertheless, we can say that, though he descended from a family of Sephardic Jews,[15] lived in Egypt, once held a Spanish passport,[16] and eventually gained

---

[13] 1982, *Visible and Tangible Mathematics*, New York: Educational Solutions.
[14] Many practitioners have written about their implementation of Gattegno's pedagogical approach in mathematics, but a list of such articles would be too numerous to mention here. Nevertheless, three articles by this author are Powell (1995 and 1993), Powell and Ramnauth (1992), and Powell and Hoffman (1991).
[15] It is most probably that Gattegno's ancestors emigrated to Egypt due to the ruthless expulsion of Muslims and Jews from Spain during its Inquisition (1478-1834).
[16] Gattegno renounced his Spanish citizenship in protest over the fascism of Franco's reign in Spain.

British citizenship, Gattegno bypassed nationality, freed himself of labels and flags (Tahta, 1997), and became a citizen of the world. He was an autodidact, a scientist, a teacher, and a student of human learning. He not only was an educator of international proportions and created a number of important, innovative techniques for the teaching and learning of languages and mathematics but also made a seminal contribution to understanding the learning process, at all ages (Tahta, 1989a, p. 9). He published more than fifty books and countless other writings on his epistemological, psychological,[17] and pedagogical research, including his theories concerning the teaching of mathematics, reading, writing, and languages. He believed in and respected the powers that every person possesses for learning any discipline. In 1985, referring to mathematics education in the final paragraph of the preface to *Aperçu historique sur la Commission Internationale pour l'Étude et l'Amélioration de l'Enseignement des Mathématiques*,[18] he stated that "no-one should be deprived of the joy of mathematical discovery that we know to be within everyone's reach because it

---

[17] In 1979, in a brief statement indicating the focus of his investigations in psychology and their contribution to the field until then, Gattegno summarizes as follows:

> In my own work (which I located within psychology) I studied learning as a conscious act of a self endowed with many attributes such as awareness, will, intelligence, discrimination, retention, perception, imaging and so on. I became convinced that psychology could be defined as the science of time, the time we consume for experiencing. Looking at what we did with our time from conception on helped me shed new light on several phenomena which either had been poorly understood until then or had been left out altogether. In particular, my studies of learning yielded not only what Cognitive psychologists hoped to find in their own studies but allowed me to offer a technology for education that proved me closer to knowing what knowing is than was possible in the existing laboratories (p. 8).

Here he uses technically terms such as *self*, *awareness*, and *knowing*. To expose his meanings would require more space than allotted. Fortunately, however, he discusses his technical terms in many of his publications (see, for example, Gattegno, 1988a). He gave his "technology for education" material expression in the materials he developed for the teaching and learning of reading, writing, languages, and mathematics.

[18] Translation: A Brief History of the International Commission for the Study and Improvement of the Teaching of Mathematics.

has been within ours."[19] For Gattegno, this statement is neither gratuitous nor reflective of merely a romantic, egalitarian sentiment of a socialist discourse. In his writings and seminars, he forcefully insisted on this statement since he understood that, in every cultural group, each person independently and autonomously teaches him or herself so much during the first years of life, not the least of which is to speak. He presented evidence for his judgment in many of his books such as in *What We Owe Children* (1970), *The Universe of Babies* (1973), *The Mind Teaches the Brain* (1988a), and *The science of education, Part I: Theoretical Considerations* (1987).

[19] Translated by Dick Tahta from the French original: "personne ne devrait étre privé de la joie de la découverte mathématique que nous savons étre á la portée de tous parce qu'elle a été á notre portée."

Bibliography

Gattegno, Caleb (1958). *Modern mathematics with numbers in color*. Reading, England: Educational Explorers.

_____. (1963). *For the teaching of mathematics*, 3 volumes. Reading, England: Educational Explores. (Available New York: Educational Solutions.)

_____. (1967). Functioning as a mathematician. *Mathematics Teaching*, 39, 6-9.

_____. (1970) *What we owe children*. New York: Outerbridge & Dienstrey

_____. (1973). *The universe of babies*. New York: Educational Solutions.

_____. (1974). *The common sense of teaching mathematics*. New York: Educational Solutions.

_____. (1975). *Now Johnny can do arithmetic: A handbook on the use of colored rods*. New York: Educational Solutions.

_____. (1976). *The common sense of teaching foreign languages*. New York: Educational Solutions.

_____. (1979). Knowing: epistemology or psychology? *Educational Solutions Newsletter*, 9(2), 2-13.

_____. (1980). The foundations of geometry. *For the Learning of Mathematics*, 1(1), 10-16.

_____. (ca. 1980). Curriculum vita. Unpublished manuscript.

_____. (1983). Looking back and then forward. *Educational Solutions Newsletter*, 12(5), 3-13.

_____. (1984a). Curriculum and epistemology. *For the Learning of Mathematics*, 4(2), 33-38.

_____. (1984b). Curriculum and epistemology II. *For the Learning of Mathematics*, 4(3), 19-22.

_____. (1985a). *The common sense of teaching reading and writing*. New York: Educational Solutions.

_____. (1985b). Preface. In Lucienne Félix, *Aperçu historique sur la Commission Internationale pour l'Étude et l'Amélioration de l'Enseignement des Mathématiques*.

_____. (1987). *The science of education, Part I: Theoretical Considerations*. New York: Educational Solutions.

_____. (1988a). *The mind teaches the brain*, Revised edition. New York: Educational Solutions.

_____. (1988b). Reflections on forty years of work on mathematics teaching. *For the Learning of Mathematics*, 8(3), 41-42.

_____. (1988c). *The science of education, Part II: The awareness of mathematization*. New York: Educational Solutions.

Felix, Lucienne (ca. 1985). *Apercu historique sur la Commission Internationale pour l'Étude et l'Amélioration de l'Enseignement des Mathématiques*.

Powell, Arthur B. (1995). Forcing Awareness of Mathematics: Self, Mind, and Content in Dialogue, *La Science de L'Education en Questions*, 12, 21-24.

_____. (1993). Pedagogy as ideology: Using Gattegno to explore functions with graphing calculator and transactional writing. In C. Julie, D. Angelis, & Z. Davis (Eds.), *Proceeding of the Second International Conference on the Political Dimensions of Mathematics Education*, 356-369. Cape Town: Maskew Miller Longman.

Powell, Arthur B. and Ramnauth, Mahendra (1992). Beyond questions and answers: Prompting reflections and deepening understandings of mathematics using multiple-entry logs. *For the Learning of Mathematics*, 12(2), 12-18.

Powell, Arthur B. and Hoffman, Martin R. (1991). Gattegno and Freire: A model for teaching mathematically underprepared, working-class students. In R. Noss, A. Brown, P. Drake, P. Dowling, Pat Drake, M. Harris, C. Hoyles, & S. Mellin-Olsen (Eds.), *Political Dimensions of Mathematics Education: Action and Critique: Proceedings of the First International Conference, 1-4 April 1990*, Revised Edition. London: University of London.

Tahta, Dick (1989a). Foreword, *A Gattegno anthology*, Derby, England: Association of Teachers of Mathematics, 9-10.

_____. (1989b). CG bibliography. Unpublished manuscript.

_____. (1997). Personal communication.