



Classroom at the Edge of Chaos: Towards a Pedagogy of Complex Systems Theory

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Abstract

My pedagogy is the focus on 3 big questions: what is the universe (and how does it work); what is a human being; and what is the place of that human being in that universe? My focus is on questions, not on answers. My approach is to further the ability of students, individually and in groups, to ask better questions, with more joy. The image is Albert Einstein riding his bicycle at Caltech. He rose to be Time Magazine's Man of the Century, among the greatest concentration of scientists in Berlin, among whom would be over a dozen who won Nobel Prizes, because he asked the best questions. He played the violin. His hair style and life style was bohemian. And in the Caltech photos (and the famous photographic portrait taken by my great uncle) he is smiling, on the edge of breaking out in laughter.

Style, like real life, cannot be too precious, controlled or confining. There is a great deal of theory in the Classroom Management Plan of the Future. Not just the minimum of 3 theorists (Dreikurs and the many philosophers and scientific researchers cited), but the tip of an iceberg of thousands of peer-reviewed papers on the universe and the human being. But theory alone ill-equips a teacher. What I write here also comes from common sense experience with over 3,000 students, teenagers through over 90 years old, in a dozen different subjects, since 1973. The teacher does not control the classroom. The teacher does not confine the students to proper instructional attitude. Real life, in the classroom, is messy as well. The techniques of Classroom Management are ways to minimize the mess that will happen regardless of good intentions. The Social Contract is a realistic basis for encountering the mess, just as the United States Constitution has stood two centuries of messy history. Thus a balance can be achieved of instruction, assessment, and management.

The teacher, in his or her mind, narrates or paints an accurate portrait of minute feelings. The human beings in the classroom are thinkers, yes, but also human because of a full palette of emotions. Adolescent students, going through a "phase transition" in their lives, their brains rewiring themselves, their bodies flooded with hormones, have their social network quivering like a spiderweb shaking in the morning breeze, their sense of belonging to pairs and trios and subgroups in and beyond the classroom under repeated reappraisal. The teacher must respect the dignity of the student, giving attention to the minute variations in feeling, encouraging the positive, enabling the negative to be self- and group-regulated.

As Philosopher of History Samuel P. Huntington writes in his first sentence:

"The most important political distinction among countries concerns not their form of government but their degree of government. The differences between democracy and dictatorship are less than the differences between those countries whose politics embodies consensus, community, legitimacy, organization, effectiveness, stability, and those countries whose politics is deficient in those qualities."

[Political Order in Changing Societies (The Henry L. Stimson Lectures Series) (Paperback), by Samuel P. Huntington, 488 pages, Yale University Press, 1970]



This remarkable and underappreciated book is Hobbesian in outlook and Hegelian in method. That the book is Hobbesian in outlook is indicated by the justly famous opening sentence, and confirmed by Huntington's elaboration of that statement: "The function of government is to govern. A weak government, a government which lacks authority, fails to perform its function and is immoral in the same sense in which a corrupt judge, a cowardly soldier, or an IGNORANT TEACHER is immoral" (p. 28, emphasis by Jonathan Vos Post).

Samuel P. Huntington, better known today (and linked to Francis Fukuyama who wrote a new foreword for the 2006 edition) for his theory of the "Clash of Civilizations" goes on to quote Walter Lippman:

"I do know that there is no greater necessity for men who live in communities than that they be governed, self-governed if possible, well-governed if they are fortunate, but in any event, governed." [Walter Lippman, New York Herald Tribune, 10 Dec 1963, p.24, quoted in Huntington, Op. Cit., p. 2]

This Complex Systems Future Classroom Plan is a rough cut of my characterization of a motivational style/approach, informed by art and cutting-edge science, intended to guide the self-government of students asking great questions, and living a life worth living.

As Edward Frenkel wrote:

"Imagine you had to take an art class in which you were taught how to paint a fence or a wall, but you were never shown the paintings of the great masters, and you weren't even told that such paintings existed. Pretty soon you'd be asking, why study art?"

"That's absurd, of course, but it's surprisingly close to the way we teach children mathematics. In elementary and middle school and even into high school, we hide math's great masterpieces from students' view. The arithmetic, algebraic equations and geometric proofs we do teach are important, but they are to mathematics what whitewashing a fence is to Picasso — so reductive it's almost a lie."

"Most of us never get to see the real mathematics because our current math curriculum is more than 1,000 years old. For example, the formula for solutions of quadratic equations was in al-Khwarizmi's book published in 830, and Euclid laid the foundations of Euclidean geometry around 300 BC. If the same time warp were true in physics or biology, we wouldn't know about the solar system, the atom and DNA. This creates an extraordinary educational gap for our kids, schools and society."

How I see My Own Educational/Authorial Complex System

I see myself as a dynamic node in several interlocking networks. I am an author and teacher node, and maintain a functional process of catalyzing the production of texts (Homework assignments, quizzes, midterm exams, final exams, drafts of short stories, novelettes, novellas, novels, and other types) which are polymers of paragraphs. Paragraphs are made of sentences which are made of words which are made of letters, but I focus on the paragraph, because that is an emotional unit. Something happens to someone, with sensory data, emotions and thoughts. The growth of the polymer is catalytic, and there are editorial things happening, also enzymatic in a sense. I can describe the production of text in terms of an analogue of the Michaelis Menten equations. The product (akin to a protein) has a primary structure, the sequence of paragraphs, and a secondary structure, usually in terms of chapters and a skeleton of cover, copyright page, cover page, foreword or preface, table of contents, introduction, story chapters, possibly an epilogue, author biographical/bibliographic pages, index. It folds into a tertiary structure, through structures such as trilogies, interaction with reviewers and marketers and placement on the desks of students, and on retail and library shelves and the homes of readers.



I am an open system. Flowing into me is a substrate, information from the environment. Some of this comes from Nature; some from other human beings, some of whom are also author nodes. There are authors who influence me through their bodies of work, alive and dead. There are authors with whom I collaborate in various ways. Those collaborations form a network. Flowing out of me are Product (texts) after being catalytically transformed by a sequence of processes, with some feedback and feedforward controls, through a sequence of intermediates (drafts). Being an author (and teacher) means having both conscious and unconscious control of the flux of information, quantized as texts and student interactions.

My texts can be transmitted to editors, perhaps through the intervention of literary agents. These are two kinds of humans which have important links in the network with author nodes. Editors can transform texts, but perhaps more important, they can acquire and publish texts, as magazines and books. That sends money to the authors. Economics is the science that analyzes the text/money interactions.

When published, the texts are read by readers, which are human beings as a different kind of node. A person can be both a reader and an author, or both an editor and an author, both a teacher and an author, or various other combinations. Some readers send money to editors (via a chain of retailers, jobbers, wholesalers, and distributors). Economics also analyzes the reader/text/money transactions. I am ultimately building a body of work. Over 4,400 publications presentations and broadcasts which have been published to my credit, roughly a thousand are in inventory in various states of partial or complete status. I have taught between 3,000 and 5,000 students.

Sketch of a 3-D Lesson Plan, Whose Efficacy has been Statistically Assessed

If we live in a 3-dimensional world, then why are students struggling in High School Geometry with 2-dimensional sheets of paper, 2-dimensional drawings on the whiteboard, and 2-dimensional computer screens? I wanted to do Action Research that we determine if a 1-hour lesson that involved Realia, hands-on construction of certain 3-dimensional shapes, guided instruction emphasizing self-discovery, and minimal lectures that attempted higher levels of Bloom's Taxonomy to relate this to other sensory modalities, would tap into the sense of Beauty in students, engage them, provide an enjoyable experience, and change their self-assessment and their feelings about Mathematics.

Through the 1950s in America, geometry was often taught based on Euclid's geometry, the most successful textbook of all time, having gone through over 1,000 editions and translations. In particular, students all learned Solid Geometry. In the late 20th and early 21st Century, geometry was "dumbed down" despite new technologies that should have allowed the content to be "beefed up." The group projects in my Action Research lesson plan gave today's students as good – or better – a tactile and visual and kinaesthetic grasp of certain key 3-dimensional shapes as students of past centuries attained by more abstract means.

These shapes are also BEAUTIFUL. [This connects to my lecture emphasis on Truth and Beauty in Mathematics, and as summarized by the poet John Keats].

Students were familiarized to the vocabulary using realia (defined below) as well as by a table that they constructed by peer teaching on the white board. They BUILT several of the shapes discussed out of paper and glue, to make visually attractive realia which were passed from hand to hand, rotated, manipulated, and compared. Realia is a term used in library science and education to refer to certain real-life objects.



The concept was introduced to the learners utilizing a situation that they may encounter in their present lives. The class used the same word problem to build their mathematical understanding, moving from the scenario, to values, and finally to terms, thus gradually establishing a solid foundation. In this manner, the teacher/lesson-planner expected that students will learn not only the new mathematical knowledge but also a connection of how these mathematical concepts are important in their everyday lives.

I used a class of 13 male and female 9th, 10th, and 11th grade Geometry students at Stern Math and Science School, on the edge of the Cal State L.A. Classroom.

By an overwhelming majority, students indicated:

(a) The Students were engaged and attending; (b) Transfer of learning occurred

Transfer of learning is evinced by the regular teacher indicating on her survey that this use of 3-D instruction was “Essential” for their 2-D Geometry comprehension to standards, and her strong desire for follow-up. I was very comfortable, and I think the video shows that. The students seemed to share in that comfort level. The lesson was effective because: (1) 100% of students generated work products; (2) which they analyzed and used to make a table of data on the whiteboard; (3) and discussed intelligently; (4) and the survey showed a TRANSFORMATIVE effect on their assessment of the subject matter as content and emotional engagement. Topic integration has been mentioned: Math connected to real life (i.e. buildings and bridges as geometric structures); to Aesthetics; to hand-eye coordination; to abstract concept of Dimensions; to Philosophers Plato, Socrates); to English Literature (Keats): “Beauty is truth, truth beauty, that is all ye know on earth, and all ye need to know.”

In the end [details available upon request], I've measured how students found Geometry fun, or beautiful, and whether they thought that they could increase their own intelligence, thus, increasing my ability to relate to such students and to become a better, more efficient Mathematics educator through this new understanding.

THE FULL 8,650 word paper available [includes extensive bibliography] on request to:
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