AN OLD MATH PROGRAM

by
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Abstract. A math program for grades K through 12 is described in which math anxiety may be avoided by adherence to historical order, the use of multiple modes, and other old tricks.

CONTENTS

1. INTRODUCTION: OUR HYPOTHESES

As mathematics is the universal language of space-time pattern, and the common modeling strategy of all academic disciplines, math skills give us enormous advantage in conceptual integration of historical data, and in understanding the gigantic complex system in which we are now enmeshed. And as this has always been so, the epochs of world cultural history are characterized by their mathematical styles, as described by William Irwin Thompson in his scheme of cultural ecologies. For all these reasons, math skills have a special emphasis throughout our program.

The mathematics element of our curriculum proposal is based on several assumptions, which we will briefly introduce in this chapter. First and most important is the conviction that we are now in a major social transformation, which may understand best in the context of earlier shifts in world cultural history. Second in importance is the Sheldrake principle, which is the basis for our historical approach to the whole curriculum, and is particularly important for the math element. Next comes our theory of math anxiety, which provides the strongest motivation for the historical approach to mathematics. Finally, we present our special view of Euclid's geometry, and justify our faith in it as an approach to math education for the future. Besides all its traditional virtues, we now see it as the essential prerequisite for chaos theory, which is an important goal of our math program.

Bifurcations

Our emphasis on historical transformation derives from our conviction that we are now in one, a social bifurcation on a massive scale. Through an understanding of earlier transformation events, we may improve our chances of surviving this one, and creating a viable future for humankind on planet Earth. Recently, models for these transformational events have emerged in chaos theory, a new branch of mathematics. This level of understanding is a goal of our program.

The Sheldrake principle

Rupert Sheldrake is a contemporary English biologist and neovitalist, who has proposed that a hypothetical field, the morphogenetic field, is the organizer of forms in nature. As a corollary of his theory, he has suggested that individuals may learn a subject most easily in historical order. We call this idea the Sheldrake principle. Applying this principle, our overall program follows the time sequence of world cultural history through the sequence of school grades. And so, in turn, does our integrated math program.

The rectified Sheldrake principle

There many ways of mapping the time scale of history onto the time frame of the elementary school grades. Taking into account the dynamical view of history, in which the major transformations play a special role, we have aligned the main bifurcations of cultural history with the main developmental bifurcations according to Piaget. This uniquely determines the mapping from history to grades, and is called the *rectified Sheldrake principle*.

2. FREQUENTLY ASKED QUESTIONS (FAQs)

What is mathematics? (9 Qs)

M1. What is mathematics?

Math is changing. Since the computer revolution, a new image of the subject is gaining acceptance: the study of space-time patterns. Dynamic math is outpacing the static concepts established by the ancients. Presently the main branches are usually listed as: arithmetic, geometry, algebra, and dynamics (aka analysis). Sometimes logic, topology, chaos theory, and others, are listed as well. We may refer to the branches by the code: RGADX (mnemonically, *argadix*) for arithmetic, geometry, algebra, dynamics, and chaos theory.

M2. How did math evolve?

Math has evolved in giant steps since the development of language by our ancestors. Math may even be older than speech. In fact, it is even possible that speech evolved from mathematics. More recently, the larger steps in the evolution of math have coincided with the major transformations of world cultural history, as noted by Thompson in his book, *Pacific Shift*. With approximate dates, these shifts are:

- R/G, ancient Greece, 600 BCE
- G/A, early Islam, 800 CE
- A/D, Newton and Leibniz, Enlightenment, 1660
- D/X, atomic, computer, etc, 1945 or 1972.

When a new one comes to the fore, the earlier ones continue.

M3. What is arithmetic?

Arithmetic is all about numbers, counting, order, etc. It is ancient but still evolving, albeit slowly, eg, finding more primes.

M4. What is geometry?

Geometry is the study of spatial (static) patterns such as triangles, circles, cubes, pyramids, etc. This ancient branch of math is still evolving, eg, noneuclidean geometry around 1750, fractal geometry in 1972.

M5. What is algebra?

Algebra is an extension of arithmetic dealing with the solution of equations. Geometric algebra is an intermediate step in which geometrical constructions are used to solve equations.

M6. What is dynamics?

Dynamics deals with the analysis of motion in terms of distance, velocity, acceleration, and so on. In its recent development there is an emphasis on the so called qualitative theory, and the long term behavior: where will this moving system end up?

M7. What is chaos theory?

Chaos theory is a further development of qualitative dynamics, in which the long term behavior is chaotic, that is, neither fixed nor periodic.

M8. Why do we learn RGA in school but not DX?

All are useful in daily life as well as in scientific professions. R and G were established in the classical tradition as part of its curriculum, the quadrivium. A arrived in the Middle Ages and became part of the traditional school program in the Renaissance. D is relatively new, was for college seniors in my parents time, and has now descended to high school in Europe, and early college in the USA. X has just burst into popular consciousness in the past decade. It has yet to make a dent on most schools, but we areworking on changing that.

M9. How have computers changed things?

Computers have radically changed the way math is done and taught, and new knowledge found, especially in X.

Why math anxiety? (12 Qs)

A. What is MA?

Math anxiety is a pathology produced in many individuals during their school years, due to weakness in the math program followed by their school. It is widespread in the USA especially, due to the conformity of most schools to a seriously flawed curriculum.

A2. What are its effects?

Math anxiety is a cognitive disability, in which a natural human capacity for mathing is rather completely lost. Even some people who succeed in technical and mathematical professions may be functioning at a fraction of their full potential due of the debilitating effects of this acquired disease. Its primary symptom of course is a flush of anxiety (math anxiety) or the urge to flee (math avoidance syndrome) when math comes up.

A3. What are its causes?

This is my theory. The school curriculum has a bug, such that a math topic is presented sooner or later (frequently around grade 7 or 8) which cannot be acquired. For example, if prerequisite concepts or cognitive skills are unavailable, the student cannot engulf the new topic, does not master it, and gets the erroneous impression that he or she is at fault. More specifically, these are the usual problems:

- multiple representations are required, but one (usually the visual representation) is missing,
- geometric constructions, which build visual intelligence have been omitted from the program (they belong in the curriculum from the earliest grades onward),
- the concept of an unknown number (basic to algebra) is introduced to early or too abruptly,
- the historical order of math (basic to Euclid, and to the history-based curriculum) has been recently replaced by the logical order, violating the Sheldrake Principle.

A4. Who is Sheldrake?

Rupert Sheldrake is a contemporary biologist, author of the theory of formative causation, according to which, knowledge evolves in a knowledge field, from which we learn by a process of resonance.

A5. What is the Sheldrake Principle?

The Sheldrake Principle, in the area of education, says that concepts are most easily learned in historical order

A6. Who is Thompson?

William Irwin Thompson is a contemporary cultural historian, who has organized world cultural history in a sequence of major stages, like the ancient Egyptians, Vico, and others. But the Thompson scheme is characterized by mathematical styles, and is the basis of a new curriculum developed by Thompson and Abraham (T&A) for the Ross School.

A7. What is the Thompson Scheme?

The Thompson Scheme has four stages:

- riverine, arithmetic, R (4000bc - 500bc)
- classical, geometric, G (500bc - 1689ad)
- modern, dynamic, D (1700 - 1970)
- biospheric, chaotic, X (from 1970 on)

A8. What is the T&A curriculum?

The T&A curriculum is a mapping of world cultural history onto the grades:

- epipaleolithic (late stone age) to K, 1
- mesolithic and early neolithic (agriculture) to 2, 3
- riverine (first city states) to 4, 5 (ancient Indus, Sumer, Egypt)
- classical (Greek, Roman, etc) and medieval, to 6, 7, 8
- modern to 9,
- biospheric to 11, 12.

This mapping attempts to coordinate the major bifurcations of world cultural history (according to the Thompson Scheme) with the stages of child development according to Piaget and others.

A9. What are the cognitive styles, intelligences?

It has long been known that math requires the coordinated modes of verbal, visual, and symbolic representation, as in the dynapic technique. More recently, this traditional view has received support in the work of Howard Gardner on multiple intelligences. We believe that the coordination of the various cognitive modes and their balanced development in childhood are encouraged by correct math training.

A10. What is the dynapic technique?

The dynapic technique is the method mathematicians use to communicate among themselves: verbal description is multiplexed with symbolic statements, in synch with a drawing made line by line.

A11. What are the standard tests, and what role do they play in MA?

Standard tests dominate the programs in schools, public or private, and cripple the evolutionary tendency of teachers, pupils, and parents to adapt the curriculum to the individual skills and needs. This worldwide tendency is antievolutionary in that the standard tests are very expensive and therefore slow to change. Perhaps more in math than in other subjects, the cognitive modes used in the tests are poorly adapted to the subject, and training for the test deviates from a balanced and coordinated development of modes. In particular, the visual mode is under utilized, or uncoordinated with verbal and symbolic modes: no dynapics on the printed page.

A12. How could we avoid MA?

To avoid MA, the math curriculum should follow historical order, integrate with other disciplines, follow Euclid, and make use of the dynapic technique. Multimedia supplemental materials maybe used to augment the traditional textbook-based program, beginning in middle schools at least. It would be necessary to bypass the standard tests, or to resist training for multiple choice questions at least, to make space in the program for the dynapic presentation of historical material, for example, the constructions of Euclid.

Why Euclid? (6 Qs)

E1. Who was Euclid?

After the R/G bifurcation around 500 BC, arithmetic, geometry, and geometric algebra were rapidly developed by the Pythagoreans. This rapid development culminated in the Academy of Plato around 350 BC, the results were collected in logical sequence in texts called *stocheia* (elements) by various editors. Euclid was one of these, and his text was so successful that it became the second most published book of all time, after the Bible, and the most influential math text of all time, until very recently. As the *Elements* were abandoned and replaced by inferior works, the math crisis and MA rapidly grew.

E2. What are the EE?

The *Elements of Euclid* develop in 13 books containing 645 propositions:

- plane geometry of triangles,
- plane geometry of circles,
- regular polygons in or around a circle,
- proportions (ratios),
- number theory, and
- solid geometry, esp, of the regular solids.

Of these 645 propositions, 60 are constructions, the others are used to prove that the constructions work reliably. The *kataskeuai* (pronounced *catas-Q-I*, meaning *constructions*) may be regarded as the skeleton, the goal, and the most ancient part of the elements, also known as *sacred geometry* and as *ancient geometry*, fundamental to the classical cultural ecology in the sense of William Irwin Thompson, and embedded in stone by the architects and builders of ancient times. The 48 fundamental constructions of plane geometry comprise the heart of the classical math curriculum.

E3. Why has the EE been so successful

In editing the *Elements*, Euclid was meticulously faithful to the Sheldrake principle, the preservation of historical order. This is the reason that constructions of the golden section appear twice:

- in book 4, according to the Pythagoreans, and
- in book 6, after the theory of proportions,

as Heath notes in his commentary.

E4. Why were the EE abandoned?

After the Enlightenment, ca 1800, the logic of Aristotle was blown up into a new paradigm for mathematics, called formalism. The months were renamed (eg, *July* became *Brumaire* in French) to avoid the taint of history, and math was reorganized according to its logical, as opposed to its historical, order. The *Elements* of Euclid followed the traditional names of the months into the trash bin, and there began a disease of our current cultural ecology, of which MA is but one of the symptoms.

E5. Why should we return to the EE?

The restoration of Euclid as a basic math text for the middle and high schools would be a giant step toward the elimination of the math disease of our time. It is not the only step required, we would also need to retrain teachers to understand it, and to use the dynapic technique to teach it, as classical teachers used to do.

E6. How could we return to the EE?

The revision of the school math program could be done by:

- creating adequate new texts for a new program, such as new, multimedia editions of Euclid,
- retraining teachers to understand and follow the crucial sequence: geometry, geometric algebra, algebra,
- training teachers to use dynapics, and
- abandoning standard tests which misrepresent math.

Why dynamics and chaos? (10 Qs)

D1: What is dynamical systems theory?

Dynamical systems theory is the branch of mathematics devoted to the motions of systems which evolve according to simple rules. It was developed originally in the 17th century by Newton to model the motions of our solar system, evolving under the rules of his new theory of universal gravitation.

D2: What is chaos theory?

Chaos theory is a further development of dynamical systems theory which focuses on highly complex motions called chaotic motions. These were discovered originally by Poincare around 1890 in his unsuccessful efforts to prove the stability of the solar system.

D3: What is a chaotic motion?

By the broadest definition, every motion more complicated than fixed (no motion) or periodic (cyclically repeating) motion is considered chaotic.

D4: What do you mean by the chaos revolution?

Chaos theory was not known by this name until 1975 or so. For almost a century it was a minor undercurrent of dynamical systems theory, a topic of pure mathematics unknown to the scientific community. After the computer revolution, chaotic motions became visible on computer graphic screens, and an awareness of their significance began to spread among scientists. In 1971 this awareness materialized as a technical report published in a journal of theoretical physics, and the chaos revolution was on. It took about 15 years more to sweep throughout the sciences and reach public awareness. All this amounts to a major paradigm shift, as chaotic behavior moved from mystery to familiarity.

D5: Why is chaos theory important?

Every branch of pure mathematics has applications, usually to science or technology, which are important to society. In the case of dynamical systems theory, extensive and ongoing applications to all of the physical, biological, and social sciences have been fundamental to our evolving culture. The most frequent kind of application is to the technology of modeling complex natural systems. The importance of chaos theory has been in the context of this modeling aspect of applied dynamics. Because of the new wisdom of chaotic motions, many more complex systems now have useful models: the biosphere, the global economy, the human immune system, and so on. Different models for subsystems, created by scientists of disjoint specialities, may now be combined into a single complex supermodel, thanks to chaos theory. It provides a new technique for the unification of the sciences.

D6: Is the chaos of chaos theory the same as the chaos in everyday life?

Off hand it is not obvious that the chaotic motions of chaos theory have any direct bearing on the chaotic experiences of everyday life. However, as the applications of chaos theory to the social sciences evolve, more and more everyday chaos is brought into the embrace of chaos theory.

D7: Is chaos theory taught in universities?

Sadly, no. While a small number of universities offer a course in chaos theory in their physics or math departments, there are comprehensive chaos theory programs taught by experts in the field only at a handful of universities.

D8: What background is required to understand chaos theory?

As chaos theory is a new branch of math, it is relatively independent of the main topics of the traditional program. Therefore it is quite accessible to people without extensive math background. Calculus, for example, is not required. The plane geometry of Euclid is an excellent preparation.

D9: Should chaos theory be taught in high schools?

Absolutely. The applicability of chaos theory to the complex space-time patterns observed in nature and in human society make it an important subject for everyone to learn. And the paucity of background knowledge required makes it accessible to all.

D10: How does chaos theory relate to math anxiety?

Math anxiety is usually triggered by high school algebra and its arcane symbolic notations, while most students feel comfortable with geometry. As chaos theory builds upon geometry without requiring algebra, it provides a fresh start for those afflicted with math anxiety, and may actually restore math confidence.

3. The SAT

Introduction

In a nutshell, we have described the math program of schools worldwide, and especially in America, as stuck in a loop. A faulty program presents the wrong material, out of sequence, without adequate cognitive modes, so that students must fail. Young people of all levels of natural ability are convinced that they cannot learn math. These people become parents with math anxiety, which is then passed on to their children: *a family disease*.

Question: Why is there no evolution of the school math program, so that these bugs are corrected?

Answer: Standard tests such as the SAT resist curriculum reform.

Question: What is the SAT and why and how does it resist curriculum reform?

Answer: Read on. Rather than deconstructing the SAT all by myself, I will call upon the extensive literature on the subject.

Chronology of mental measurement

This chronology is extracted from (Owen, 1985). For th full story, see Chapter 5 of the delightful (Gould, 1996).

1900, Alfred Binet test for children; CEEB founded

1910, Henry Goddard, tr. Binet test into English

1916, Louis Terman, the Stanford-Binet test

1917, Robert M. Yerkes, Army mental tests

1923, Carl Campbell Brigham, racist bigot at Princeton

1925, Brigham hired by CEEB to develop SAT

1940, World War 2 boosted the SAT, essay tests abandoned

1947, ETS created by CEEB, testing boom

Annotated bibliography

We now provide some brief notes on several works, in chronological order, which support our position on the SAT. Note that our chronology of opposition to the SAT begins in 1945, before even the creation of ETS.

Barzun, Teacher in America, 1945

Jacques Barzun, born in France, moved to America in his teen years, and became Professor of History at Columbia College in New York City around 1920. He is the author of a number of books and many articles in the popular press.

Teacher in America is a thorough critique of higher education in America, full of personal impressions and theories about every aspect of the subject. Of the 21 chapters, there is one devoted to examinations, *Chapter 15: "Your I.Q. or Your Life"*, about 11 pages long. While generally in favor of examinations, Barzun derides:

- I.Q. tests,
- the Thorndike test,
- psychological surveys,
- vocational tests,
- multiple choice exams, and
- the GRE exam.

He complains that these tests do not measure what they are supposed to measure, and he gives explicit voice to the theory that the tests are biased against the best students. [p. 213]

Whyte, The Organization Man, 1956

William Whyte was a journalist who wrote extensively for *Fortune*, and authored a number of books. In this one he invents a new class of Americans, with their industries and home life. His predictions of 1956 have largely come about. In one of seven parts, *Part IV, The testing of the organization man*, he takes to task the mass testing of personality. He provides a dummy test with an answer key, and tips on test-taking. He quotes Barzun, with whom he agrees that "the sheer mechanics of the tests punish the exceptional man." [p. 197]

Barzun, The House of Intellect, 1959

This, Barzun's 21st book, is a bitter lament on the loss of intellect in the United States and Europe. One of the chief targets in this litany of doom is the educational system, which is seen in a herneutical circle with its ambient culture. Two chapters are devoted do the illnesses of schools:

- Chapter IV, Education Without Instruction

- Chapter V, Instruction Without Authority

In the latter, as just one of a large number of complaints, we find, “this so-called ‘technique of educational measurement’ or objective test,” with a footnote giving credit to Banesh Hoffman’s article in the Spring 1959 issue of *The American Scholar* as the first discussion of such tests. [p. 139] Barzun throws this down with:

> No other single practice explains more fully the intellectual defects of our students up to and through graduate school than their ingrained association of knowledge and thought with the scratching down of check marks and dotted lines.

So strongly does Barzun feel about this that he appends, at the end of the book, more than four pages of indictment quoted from Hoffman himself.

Banesh Hoffman, The Tyranny of Testing, 1962

In his Foreword, dated June 30, 1962, Jacques Barzun wrote:

> For the past 30 months [this means, since January 1960] there has been a running debate on testing triggered by Banesh Hoffman’s articles in *Harper’s Magazine*, 1961, and the *American Scholar*, 1959.

Barzun himself had questioned the tests in 1945 in his book *Teacher in America*. Here are some notes on the chapters.

1 A Little Learning Is a Dangerous Thing

This chapter condemns multiple-choice tests, in which questions are to be answered by a choice, without giving a reason. Two examples are given of multiple-choice questions having wrong answers which can be defended as right: one from Mr. Batty, 1959, the other, the “colonies” question, from the SAT booklet of 1956.

2 The Business of Testing

The story of Oscar Buros, *Mental Measurements Yearbook*, 1938. Critique of the multiple-choice testing industry.

3 The Flight from Subjectivity

Difficulties with grading essay questions: subjectivity, handwriting, etc.

4 Objectivity and Ambiguity

Weaknesses in the case of the professional testers’ case for the multiple-choice test, replete with many examples.

5 The “Best” Answer

Another problem of multiple-choice tests. The best answer requires a subjective decision because there is more than one answer which is correct, or because none is.

6 Better Minds

Multiple-choice tests discriminate against creative and clever people. CEEB tests do not correlate well with subsequent college performance.

7 “What’s in a name?”

IQ tests do not measure intelligence unless it is defined as performance on IQ tests. And in that case, the ambiguity of the name “IQ test” harms the people scored, whether high or low. The SAT (verbal and arithmetical) scores are akin to IQ scores, correlate poorly with intelligence, and

with scholastic aptitude. The English Composition test does not measure ability at English composition. In fact, the test has had a negative effect on the teaching of English composition in schools.

8 National Merit

Here, in service of his conviction that MC tests are:

- biased against the critical and creative intelligence in favor of the superficially brilliant, and
- poor indicators of actual scholastic performance,

the author goes after the National Merit Scholarship Corporation. In 1959 for example, the NMSC:

- examined almost half a million students,
- rejected 98% of them on the basis of a multiple choice test alone,
- rejected 98% of the survivors on the basis of their academic records,
- named 920 as National Merit Scholars.

Hoffman notes that, according to the NMSC itself, only 82% of these ended up in the top 25% of their class, so the predictive value is poor. Also, he pointed out that the NMSC agreed with him that the tests are not predictive of creativity.

9 Statistics

"The purpose of this chapter is mainly to undermine excessive faith in statistics" and it specifically criticizes this one: The correlation of a high school student's SAT score with the subsequent freshman grades in college is about 0.50. This correlation is less than that of the heights and weights of a random group of people.

10 Challenge to the Testers

This is a chapter of strategy. Hoffman chronicles the litany of sharp criticism aimed at the multiple-choice testing establishment, and its agility in dodging. He reasons that the best strategy for bringing out the weaknesses and forcing a response from the test industry is to expose the weaknesses of individual exemplary questions from actual tests. Also, here we find an excellent short list of the problems with multiple-choice tests. [p. 150]

The strategy was applied in two articles by Hoffman: Spring 1959, *The American Scholar*, and March 1961, *Harper's Magazine*. cf p. 157.

11 Critical Thinking

This short chapter is a critique of a single multiple-choice test question, showing once again that a poor question penalizes the most clever applicants.

12 Editorial Woes

In his *Harper's Magazine* article, Hoffman had attacked five specific questions. One, the "critical thinking" question, was revisited in this book in chapter 11 above. Here is another. The ETS had responded to the Harper's article with a booklet defending all five questions, in 1961. In this chapter Hoffman demolishes the ETS response to this one question, the "editor question".

13 "The wind bloweth where it listeth"

The question dissected in this chapter, the "wind blowing" question, is from Barzun, *The House of Intellect*, 1957, and was taken from the SAT booklet of 1956. Its style shows it to be a

model of Hoffman's style. As before, Hoffman devastates the feeble defense of the ETS to Barzun's critique.

14 Return to the Colonies

The Hoffman critique on the colony question first appeared in the *American Scholar*, Spring 1959. The ETS response, in a later issue of the same periodical, and extended in the booklet of 1961, is taken to task in this chapter.

15 Interlude on the Advantages of Science

Introduces the advantages of science questions in the challenge strategy, two such are treated in the next two chapters.

16 Einstein Slighted

Well, no point arguing with Hoffman about a physics question. The first of the two science questions busted by Hoffman, the subject of this chapter, has to do with the chemistry of combustion, and is described by ETS as of average difficulty. While the dull student goes directly to the wanted answer, a more knowledgeable student (Hoffman, for example) sees no acceptable answer. To this complaint, published first in the Harper's article, the ETS put forth its best defense, which Hoffman very convincingly shows to be inadequate. Most readers of this chapter would agree, I believe, that the subject question is a poor one, and that it is biased (unintentionally perhaps) toward the duller mind.

17 Light on the Atom

Here we find the second science question, from physics, and regarded as difficult. The devastating analysis of this SAT question also appeared in the Harper's article, and subsequently defended by the ETS in its response pamphlet. In this counter response, Hoffman makes global points against the integrity of ETS and its overall defense of multiple-choice tests.

18 David and Goliath

Here Hoffman gives us most of the detailed correspondence between a student (David) and the ETS (Goliath) in which the student complained (correctly) about a poor question on the English Composition test of March 18,1961, given at Bethesda, MD. The defense of Goliath is roundly trounced by Hoffman, and we are convinced that the ETS will go to any lengths to defend a question, no matter how faulty it may be.

19 Don't Be Pro-Test — Protest

Hoffman looked at an entire SAT test and concluded that a large proportion of the questions were defective. In conclusion, he utterly condemns multiple-choice testing, and seems to approve of the essay-type tests used in other countries.

Allan Nairn, The Reign of the ETS, 1980

From the preface:

> Study began in 1974 with interviews at ETS,... strives to show that a short, one-time, three hour gamble which can determine a life's pathway is simply not compatible with what is known about human personalities... The straightjacket that the reign of ETS has imposed on this [human talent search] can be lifted when the pattern of ETS's insupportable claims about its tests is widely understood.

Contents

The concluding Chapter 9 outlines a program of change based on studying five questions:

Q1. What are the effects of restrricting the [testing] system to multiple-choice tests developed and chosen by a single organisation?

Q2. What are academic and other institutions trying to accomplish with their admissions policies?

Q3. Should applicants have to bear the costs of the tests?

Q4. Is the ETS ranking really a meritocratic ranking?

Q5. Can significant reforms be implemented given ETS' current position?

David Owen, None of the Above: the Myth of Scholastic Aptitude, 1985

Introduction: high anxiety

Tells the story of the author's own experience taking the SAT, the mystique of the SAT, summary of Banesh Hoffman, the cult of mental measurement, introducing goliath (ETS), it is an illusion.

1. The kettle defense

The astonishing growth and financial strength of the ETS, truly a goliath.

2. Holistic grading

Essays abandoned in favor of multiple choice. The difficulty of grading essays, and how ETS has tried to get around it.

3. Multiple guess

Multiple-choice tests not objective, only one answer is correct, NY state truth-in-testing law, ETS challenged in 1981: more than one correct answer, many more bad questions, evasions by ETS, ref. to his article for *Harper's* ca 1984, ref. to Banesh Hoffman.

4. Numbers

Flawed questions, flawed grading, flawed statistical defenses of ETS.

5. Tempting the medicine freaks

How stupid questions get by the review process, the resistance of test makers.

6. Coaching

Coaching works, ETS denies that coaching works, contradicts the main case of ETS that the SAT measures aptitude, several articles and the FTC castigate ETS for dishonesty, ETS sells coaching materials.

7. Beating the test

Many coaching materials are worthless but Princeton Review Schools work and raise scores 150 points or so.

> The message in this case is that the SAT is not the test that ETS and the College Board have always claimed it to be. It's not neutral and objective. It's not curriculum-free. It's not uncoachable. It's not the same test for everyone who takes it. It's not a measure of preparation for college. [p. 140]

8. Test security

Test proctoring is poor, essentially an honor system, 70% of candidates cheat, ETS cheating detection systems do not work.

9. The cult of mental measurement

This chapter gives a history of the subject, which we have extracted as the chronology above.

10. Brains

Discussion of intelligence, aptitude, ability, achievement, etc. What can be measured, and what constitutes preparation for college? How well does the SAT actually predict college grades? SAT condemned on these grounds, despite which, it was required by 60% of four-year colleges in 1985.

11. Mythology

Colleges require the SAT, then ignore the scores. They propagate the myth but students pay. High school records are the best prediction of college performance.

12. Testing and teachers

The NTE, an SAT for teachers, has an enormous effect on our schools, reduces the quality of our teachers.

13. Testing and society: what can be done?

After a review of the case against the SAT, Owen recommends: drop the SAT altogether, abolish ETS.

App A. A poisoned question

App B. Illegal test use

James Crouse and Dale Trusheim, The Case Against the SAT, 1988.

From the Preface

> This book summarizes the results of a six-year research project on the origins and uses of the Scholastic Aptitude Test (SAT) by American colleges and universities. The SAT is sponsored by the College Entrance Examination Board, administered by the Educational Testing Service, taken by 1.5 million persons a year, and used in admissions by more than 1,500 colleges and universities.

Our research grew out of the controversy sparked by Ralph Nader and Allan Nairn in 1980 with their publication of *The Reign of ETS*, a highly critical report on the Educational Testing Service.

CONTENTS

The essences of these chapters is clear from the titles except for this last. In brief, the authors gently suggest that colleges drop the SAT. In October, 1997, a task force of the University of California actually proposed this.

Introducing the New SAT, The College Board's Official Guide, 1993.

I happened on this edition in a used bookstore and bought it. More recent editions might be different. This one has five parts.

Part 1. Introducing the New SAT.

Part II. Test-Taking Strategies.

Part III. The SAT I: Verbal Section.

Part IV. The SAT I: Math Section.

Part V. A Complete Practice Test.

Obviously it is the last two parts which concern us here. In fact, as Part IV includes practice questions, we will be satisfied to describe only this one part.

Part IV begins with a concise list of concepts the applicant needs to know, under four headings: Arithmetic, Algebra, Geometry, and Miscellaneous. Note the order, which already echoes one of our main complaints about Goliath. Other than this, we have only two objections to the concepts which are listed.

#1. Under Arithmetic we find an included item: "Word problems involving such concepts as: rate/time/distance, percents, averages" The problem with this is that we do not consider dynamics to be an arithmetic concept. The difficulties which students have with word problems may stem from this in part, while word problems on weights and measures (under geometry) may be easier. Problems on dynamics probably should be moved to the physics section of the test. The mistaken inclusion under Arithmetic inclines the school math program to undertake these concepts too early.

#2. Under Geometry we find we find an excluded item: "Formal geometric proofs." Of course these may be difficult to test with multiple choice questions. But the explicit exclusion of this material from the SAT makes likely its exclusion from the entire high school program, which is

disastrous. This has lead to the devotion of the school geometry program exclusively to the content, as opposed to the method, of geometry.

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4. Conclusion

It is time now to bring all these threads together. It is the powerful synergy of these factors which actually provides the foundation for our proposed math program for schools, grades K-12.

MA prevention

In her important book *Overcoming Math Anxiety* of 1978, Shiela Tobias points to word-solving problems as the crux of the problem of MA. The examples described in detail in that book illustrate the main flaws of the current school math program:

- domain disintegration (assuming knowledge from another discipline which is not actually available),
- time disintegration, or anachronism (requiring concepts which are to be, or should be, introduced later),
- cultural disintegration (using metaphors foreign to the cultural context of the skills required), or
- mode disintegration (making use of two few, or inappropriate, cognitive modes).

Thus we have the motivations of our program: coordination of all disciplines, historical order, integration with cultural history, and multimedia technology. While Tobias' book is aimed at curing MA, our program aims at preventing it.

In the San Jose Mercury News of July 27, 1999 is a report entitled:

> MATH: A GREAT DIVIDE: Dismal scores reveal how far California schools lag in achievig standards called among the toughest in U.S.

And then in a sidebar called, HOW TO IMPROVE PERFORMANCE, we find three suggestions:

- Train teachers in advanced math concepts.
- Try out and buy new textbooks.
- Focus on preparing students to take algebra in eighth grade. In San Jose Unified School District, administrators plan to begin preparing students for algebra as early as fourth grade.

Nothing could be worse, according to the theories presented here, especially in consideration of the fact that geometry is not presented until the ninth grade, if at all.

Euclid is historical

The constructions of Euclid span the history of mathematics from ancient Mesopotamia and Egypt up to the 17th century, that is, the time periods of grades 5-8 of our program, the epoch of the geometric mentality. They lead naturally into the introduction of the concepts of algebra which emerged around 800 AD, and its symbolic notations which came only around 1600, at the end of the geometric period. As this stage of the cultural evolution of mathematics was prerequisite to the creation of the dynamics and calculus of Newton and Leibniz, so are they prerequisite for a student learning these concepts, basic to the dynamic mentality.

Cognitive modes in evolutionary sequence

In terms of cognitive modes, the historical sequence of our program — RGADX: arithmetic, geometry, algebra, dynamics, chaos theory — provides a natural progression from primitive counting (a skill of newborns, see Stanislas Dehaene, *The Number Sense*) through visual (preverbal) modes of geometry and geometric algebra, to the rhetorical modes of early algebra, and the abstract-symbolic modes of modern mathematics, including dynamics and chaos theory.

Math and cultural history

Beyond the utilization of devices such as the rectified Sheldrake principle and the dynapic technique for success in mathematical pedagogy and the prevention of MA, our program aims at creating an awareness and understanding of the special role of mathematics in the evolution of consciousness. With immersion in a given cultural ecology, the intertwined paths of math, science/technology, languages/writing/literature, graphic arts/music, and the human knowledge base which is our speical heritage become one. The flow of this one through time, with special emphasis on the major points of bifurcation, provide the strongest base for the understanding of the present, and the creation of the future. The establishment of this base is the main goal of our integrated program, in which the math thread is an integral part.