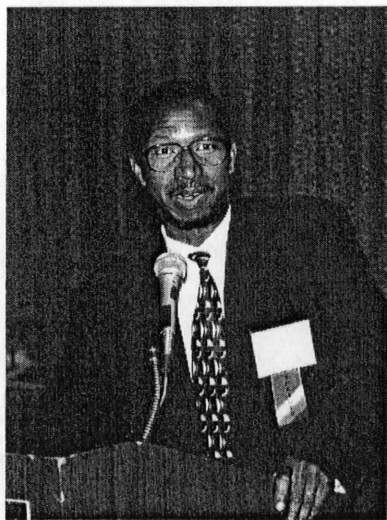


SESSION PRESENTATIONS

Traveling as far away as New York City, the students also participated in conference discussions on the use of LabWorks technology, financing graduate education, and succeeding in graduate school. Sessions like "Reinvigorating your Research Program through Collaborations," "Undergraduate Research as a Vehicle for Success for Underrepresented Students in Science and Engineering," and the "Role of Undergraduate Research in the Recruitment/Retention of Students" provided information and resources on improving undergraduate research in two-year and four-year colleges and universities. The following pages are presentations made during the conference as submitted by the speaker for these proceedings.

Avoiding (or Closing) Academic Achievement Gaps

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The Power Law and the Law of Performance: A Rosetta Stone for Deciphering the Process of Education

Recent articles in the Baton Rouge *Advocate* (<http://www.theadvocate.com>) addressed the achievement levels of students on the American College Test (ACT) and other standardized examinations. Please see "Test score gap offers challenge" (the *Advocate*, 10/02/00, page

1A), "Suburban parishes ACT scores mixed" (*Advocate*, 8/29/00, page 1B), "Reading, science scores static in national tests: gap grows between black, white students" (*Advocate*, 8/25/00, page 1A), and "1999 ACT scores of area schools" (*Advocate*, 2/29/00).

In light of the enduring interest reflected in these articles and many others, we presume that the public is interested in a com-

plete explanation of "what determines achievement levels on tests." Specifically, two publications explained, using the power law of human performance also known as the power law of practice, how achievement levels are reached [See *Education*, Vol. 115, No. 1, pp. 31-39, 1994 and pp. 11-18].

The first of these publications provides an extension of the power law known as the compound law or simply the law of practice (CLP or LP). This law clearly, unambiguously, and implacably shows that the achievement level of a student on a standardized test is directly determined, first and foremost, by (a) the exposure of that student to appropriate subject contents and skills, (b) the adequacy of the scope and depth of this exposure, and (c) the actual amount of time the student spends learning, applying, and practicing said contents and skills—in and outside the classroom. "Appropriate" and "adequate" are objectively defined by competitive standards and not some parochial or self-serving norms or criteria set by some individuals.

According to the law, socioeconomic status, ethnicity, and gender, among others, are not intrinsic factors that determine the achievement levels of students! *Their effects are indirect. Academic achievement levels depend first and foremost upon ac-*

cess to and utilization of competitively engaging, standard-based education and indirectly upon socioeconomic and cultural conditions. Negative, indirect effects of socioeconomic, ethnic, and gender factors on academic achievements, if any, can be avoided by ensuring items (a) through (c) as noted above.

The power law of practice (or of performance) and its explanation of the achievement levels of students are presented in detail in a video tape, *Genesis of Genius*, available from the Louis Stokes Louisiana Alliance for Minority Participation (LS-LAMP) at Southern University and A&M College, Baton Rouge [<http://www.ls-lamp.org>, telephone: (225) 771-2777].

Interestingly, most individuals are familiar with the necessity for items (a) through (c) in sports and the arts. It is the same for intellectual endeavors! We hope that interested parents, teachers, students, and others will take advantage of this video tape that also explains how achievement gaps between various groups of students, on standardized tests, are formed. *These gaps, according to the LP, can be avoided or closed by the application of items (a) through (c) listed above.* The Timbuktu Academy has been doing so since 1990 (<http://www.phys.subr.edu/timbuktu.htm>)! The rigorous application of the above law allows the Academy to register quantum leaps in the ACT scores of its pre-college, summer students every year. Details on these leaps are available at the web site of the Academy and upon request. In each of 2000 and 2001, 10 of these pre-college scholars of the Academy were among the National Achievement and National Merit semifinalists!

Explaining American College Test (ACT) Scores of U.S. High School Graduating Class of 1999 (Similar results are found from 1996 to 1999, with slightly changing gaps)

The law of performance (LP) explains academic achievement gaps. Note the smaller mathematics gap (mathematics) that widens with course taking! The key (i.e., Rosetta Stone) to the puzzle is that the scores, as per the LP, are determined (causally so) by the actual learning (practice)—mediated in part by (a) course taking, (b) the topics, their scope, and depth in every course, (c) the actual practice by the students as mediated (or induced) by graded homework assignments, tests, and others. *All algebra courses are not equal or equivalent; and, all students taking given courses do not devote equivalent times to these courses; the needed time for a course, incidentally, depends on the background of a given student!* Therein lies the quintessential source of differences between the achievement levels of students who took similar courses. Course taking alone, as shown in the table below, accounts for most of the rest of differences between the achievement levels of students. Genes, intelligence quotient (IQ), ethnicity, and gender do not enter into this explanation or equation.

Note the large gap, in English, for those taking less than four years of English. It is partly at the root of the large gaps, of similar sizes, in reading and in science reasoning! See exposure (at home, school, etc.) to Standard English and a rich vocabulary environment, from birth to the test date, to explain the gap in English—as per the law of performance or of practice.

Noting how the English gap contributes to the gaps in others, the Timbuktu Academy doubled the time devoted to English by its summer pre-college students in 1996-97. Following this change, ACT score improvements, over a six-week period, jumped from an average of two to an average of four or five. The strong and positive correlation between the SAT and the GRE scores in the verbal and quantitative sections, respectively, gave the Timbuktu Academy an added incentive to close the English gap. As expected, the gaps in reading and science reasoning narrowed significantly. After all, languages are the vehicles of thought. See Table I.

For the Creation of Educational Value-Added (i.e., High Academic Achievements)

(1) *The law of performance says that all students can learn—at a competitive level.* It is the scientific basis for high expectations for all students! It also says that exposure to competitive curricula, over the years, and adequate learning and practice are necessary for high academic achievements by most students.

(2) *The law of performance also says that exposure to substandard curricula, over the years, will ineluctably result in low achievements, irrespective of intellectual quotient, genes, ethnicity, gender, etc.* Whatever the reasons, tracking a student in "low ability" groups guarantees that said student will underachieve.

(3) There is no substitute for standard-based subject matter and skills content of each and every course, from pre-K to graduate school and beyond.

(4) There is no substitute for the adequacy of the battery of courses taken at every grade level. A national, reference curriculum, from K through college, will inform parents and students of prevailing competitive norms or standards.

(5) There is no way to circumvent the *internal rigidity* (i.e., sequential nature of aspects of knowledge). Consequently, the knowledge and skills base of the learner has a great influence on the "acquired ability" to learn. Particular difficulties in many courses are often due to utterly inadequate background as opposed to a lack of "smartness." Writing follows reading. Calculus follows arithmetic, algebra, and basic geometry and trigonometry.

(6) There is no substitute for the devotion of "adequate" time to learning tasks! So says the law of performance (LP). "Adequate" is to be determined using competitiveness criteria and national norms and standards. In the absence of a reference curriculum, those with the least intellectual, material, and financial means are likely to have the most difficulty in the determination of a competitive curriculum and of the "adequacy" of the time on learning tasks. This holds for parents, teachers, and students.

(7) There is no substitute for quality teaching, with its inherently closed feedback loop. Such a teaching commands a significant portion of the out-of-class time through graded assignments. These assignments simulate the actual way in which knowledge is applied and research is conducted. They do so better than any test, however comprehensive it may be. Further, they mold study habits over time; these habits are critical aspects of the unwritten curriculum.

(8) There is no substitute for parents or guardians in ensuring that adequate time is spent on learning tasks during the academic year and in the summer (i.e., reading and report writing). Consequently, they have to limit TV viewing, video playing, and listening to music. These activities and similar ones are privileges that should be earned by young students after doing school work.

(9) There is no substitute for familiarity with the format and subject/skill content of applicable tests. This tautology applies to all standardized tests, whether they are norm- or criterion-referenced, from kindergarten through the doctoral degree.

(10) There is no substitute for efforts and practice in acquiring and enhancing proficiency in a complex process, from reading to writing, research, and problem-solving, sports, and the arts. So says the law of performance, regardless of claims of "innate" abilities.

TABLE I

A comparison of the ACT scores of African American/Black and of Caucasian/White students for the graduating class of 1999. Similar results for the gaps, due to course taking and to the actual time on learning tasks of varying standards, are found for 1996 through 1998, with slightly changing gaps. In the table, E stands for English, A for Algebra, Trig. for Trigonometry, Geom. for Geometry, Hist. for History, Phys. for Physics, Chem. for chemistry.

English Course Pattern	Number of Black Students	ACT English	Number of White Students	ACT English	GAPS
E9, E10, E11, E12, Speech	24,586	17.0	250,463	21.8	4.8
E9, E10, E11, E12	69,780	16.4	422,673	21.3	
Less Than 4 years of English	5,940	14.8	38,515	19.4	4.6
<i>Course Taking Difference (top-bottom)</i>		2.2		2.4	
Mathematics Course Pattern	Number of Black Students	ACT Math	Number of White Students	ACT Math	GAPS
A 1, A 2, Geom., Trig., Calculus	4,022	19.7	46,643	25.1	5.6
A 1, A 2, Geom., Trig., other					
Advanced Mathematics	7,085	18.9	75,979	22.6	
Other comb. Of four or more years of Math (i.e., Mathematics)	18,538	19.0	170,873	24.6	
A 1, A 2, Geom., Trig.	10,442	17.3	75,307	21.1	
A 1, A 2, Geom., other Adv. Math	9,518	17.4	83,605	20.9	
Other comb. Of three or 3.5 years of Math	6,181	16.6	37,278	20.5	
A 1, A 2, Geom.	28,288	15.6	144,952	18.2	
Less Than 3 years of math	15,967	14.8	75,208	16.8	2.0
<i>Course Taking Difference (top-bottom)</i>		4.9		8.3	
Social Science Course Pattern	Number of Black Students	ACT Reading	Number of White Students	ACT Reading	GAPS
US Hist., World Hist., American Government, other History	2,522	17.8	21,612	22.8	5.0
Less than 3 years of Social Science	17,899	16.2	104,682	21.1	4.9
<i>Course Taking difference (top-bottom)</i>		1.6		1.7	
Natural Science Course Pattern	Number of Black Students	ACT Science Reasoning	Number of White Students	ACT Science Reasoning	GAPS
Gen. Science, Biology, Chem., Phys.	26,733	18.4	224,723	23.2	4.8
Less Than 3 years of Natural Science	24,921	16.1	152,562	19.5	3.4
<i>Course Taking Difference (top-bottom)</i>		2.3		3.7	

SOURCE: ACT Research Services, P. O. Box 168, Iowa City, Iowa 52243. Telephone: (319) 337-1113; Fax: (319) 339-3020. Courtesy of Merine Farmer and ACT. For the Creation of Educational Value-Added (i.e., High Academic Achievements)

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