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ABSTRACT

The great value of standardized tests for locating talent that would otherwise be likely to remain submerged and unidentified is emphasized. Such tests must be appropriate to the actual ability level of the persons tested, regardless of their grade level, so that sufficient ceilings may be obtained and power of minds probed adequately. High test scores are viewed as probably the best single initial clue to high potential, often more valid than school grades or teacher's recommendations. The goals of the five year study, which is in its second year, are: discovery, description and development. Development is understood as vigorous intervention in the educational process on behalf of highly talented students. (Author/BJG)

Using Tests to Discover Talent*

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Once a year Division 5 allows an elder of its tribe to pontificate for fifty minutes on whatever topic he or she chooses. These presidential addresses tend to be hortatory, heuristic, summarizing, philosophical, or polemic, rather than primarily substantive and empirical. My first impulse was to overwhelm you with data from t. Study of Mathematically and Scientifically Precocious Youth, which my associates and I at Johns Hopkins have been conducting for the first two years of a five-year period, funded by the Spencer Foundation that the late Lyle Spencer's Science Research Associates money founded. That would be redundant, however, because the Johns Hopkins University Press is beginning work on our volume entitled _Mathematical Talent: Discovery, Description, and Development_ (Stanley, Keating, and Fox, in press), and it should be available by next summer. Also, this Thursday morning at ten o'clock in the Viger A Room of the Chateau Champlain Hotel three of my associates (Susanne Denh   Lynn Fox, and Daniel Keating) are presenting papers about the second year of the Study.

Instead, therefore, I shall pursue a theme that, in my opinion, has been badly neglected: how valuable tests can be for quick tentative identification of intellectually promising persons. High test scores are probably the _best single_ initial clue to high potential, often more valid than school grades or teachers' recommendations. Of course, identification in this way must be preliminary, tentative, and supplemented by other evidence. There will be false positives, because not all high scorers   succeed in areas for which they seem to have talent. In my experience, however, the percent of false negatives on the basis of non-test information is usually greater; non-test procedures often tend to miss many intellectually gifted persons. This is not an either-or-matter; no wise measurement specialist would base judgments solely on test scores.

A corollary seems to be that the more testing of an initially high-scoring individual one does, the greater the dependence one can put on the test-score data when planning radically accelerated educational programs, and the less direct use one needs to make of prior school information. By testing the initially promising examinees further for several full days with aptitude and achievement tests, personality and interest inventories, and other instruments of appropriate difficulty, one can reliably predict which persons can succeed well in courses and curricula far above the ones in which they are now placed.

The matter of "appropriate difficulty" of tests has also, in my opinion, received less emphasis from measurement specialists than it merits. Recently, for instance, I was told of a sixth-grader who had a grade equivalent of 11 years 0 months on a vocabulary test. This is remarkable, but it becomes more so when the fact that this student made a perfect score on the test is revealed. Because of lack of "ceiling" she was not adequately tested, and therefore should be examined further with a more appropriately difficult test such as the verbal part of the Scholastic Aptitude Test (after she studies the practice booklet carefully).

Another example may help document this point. The 99th percentile of sixth-grade norms on the number subtest of the Academic Promise Test, published by The Psychological Corporation, is a raw score of 40 out of the 60 items. For a special mathematics-teaching project that we conducted, sixth-grade students were assembled who scored at least 40 on this measure of arithmetic ability. All of these were within the upper one percent of their grade group, but their raw scores ran from 40 to 58, a range of 18 points. Eighteen points below 40 is a raw score of 22, which is the 65th percentile. Thus, even in this apparently homogeneous group the range of talent on the variable used explicitly to select them is like that of approximately the upper one-third of the grade.

A third, closely related, point is that the higher the score the greater the potential of the scorer. Hollingworth and Cobb (1928) demonstrated this experimentally long ago, and we have added much new evidence. The previously mentioned youngsters who scored barely 40 were able, of course, but not nearly as excellent learners as those who scored much higher. Keating (1973) and Fox (in press) have treated the difficulty and validity points in considerable detail.

Too often we have allowed both ourselves and opponents of tests to believe that after a certain high score more points do not make any appreciable difference in validity. This is an empirically testable assumption, of course. I do not know of any general evidence that it is true, and do have considerable specific evidence that it is not. Very likely, the problem is that under the status quo of schools and similar organizations the extra validity is not used. If one already knows nearly everything in a course when it begins, or can learn almost instantaneously whatever little is new, ability beyond that is superfluous. What difference does it make in an eighth-grade general science class for a pupil there to score at the 90th vs. the 98th percentile of college seniors on a college-level achievement test in general science? At either level, he will probably find little challenge in the class. But if the 90th percentile student is put into an appropriately taught class with those who scored at the 98th percentile or higher, he may have difficulty keeping up. The fault is not in the validity of the test, but instead in the utter inadequacy of the general science course for both of these pupils. Such students need to be freed from their academic incarceration and given more appropriately difficult subject matter.

Well, in my preamble I have made three related assertions. To recapitulate, they are as follows:

1. Tests are a prime way--probably <u>the</u> prime one--for initially finding high-level developed aptitude or achievement.

2. It is even more important than generally realized for tests to have enough "ceiling" (and "floor," too) for each individual tested. This means bold use of tests designed for much older persons, as Hollingworth (1942) illustrated long ago.

3. The higher that examinees' scores are, the greater their potential tends to be. For appropriate criteria, validity does not drop off at the upper part of the score range of a test that is difficult enough for the persons tested.

Some Early Background

Asking your indulgence for some reminiscing, I shall go back to my beginnings and illustrate how high test scores have alerted me to previously undiscovered talent—not always usable, of course. I was born 13 years after the first form of the Binet-Simon test was published, two years after the appearance of Terman's original Stanford-Binet Intelligence Scale, and one year after the Army Alpha test was first employed. I entered the first grade (there were few public kindergartens then) in 1924, during the group-testing days of the roaring twenties, and by skipping the fourth grade got into the first year of senior high school (Grades 8-11) in 1930. While in the sixth or seventh grade I was told rather casually one spring day by the special teacher for mathematics that on what I would now call a standardized achievement-test battery my score in mathematics was at the eleventh-grade level. This puzzled me a bit, because obviously I was not in that higher grade, but my curiosity wasn't great enough to impel me to ask the teacher further about this phenomenon. I suspect that she, a fine math teacher but probably completely untrained in testing, would not have been able to inform me further.

That seems to have been the only standardized test I took during those ten years of public school. In fact, because high-school students who had grades of 90 percent or more in a subject during a given quarter were not required to take the final exam that quarter, I took few exams of any kind other than weekly or mid-quarter quizzes. This pleased me then, but the inexorable exams at college made the wisdom of those exemptions less clear later.

Standardized examinations were administered to all of us who entered the residential state junior college, but we received no information concerning the scores. Soon after graduation I tried to find out something about them, but apparently the answer sheets and score records had been discarded during the two-year period--unfortunately, not an uncommon way to treat test results, as if the mere taking of the tests conferred the benefits.

By the year that the Revised Stanford-Binet Intelligence Scales (Forms L and M) appeared (1937), I was through college and a 19-year-old senior-high-school teacher of science and mathematics in Atlanta. The next summer I attended a six-weeks session at the University of Georgia and took a standard course in tests and measurements, using Tiegs' book, from Professor Herbert Bonar Ritchie. He administered to us quite a number of tests under standard conditions, among them the Otis Self-Administering Tests of Mental Ability, the Ohio State University Psychological Examination, and the Miller Group Mental Test. This experience whetted my interest in tests. For a year or two I went around administering the Otis to my students, members of my family, various girl friends, and some of my sister's boy friends. Also, I used a standardized chemistry test in the chemistry course I was teaching, but first made sure that I had taught my class the specific point underlying every item!

The ensuing scores were, to say the least, extremely high. One student scored 30 points above the 99th percentile. He wasn't that good, but he was the No. 1 student in chemistry at Georgia Tech the next fall, so by inadvertently coaching for the test I had merely made an excellent examinee into a superb one.

During World War II I saw many personnel records and informally compared Army General Classification Test (AGCT) scores with soldiers' educational and occupational backgrounds. It became obvious to me that some of the top scorers had missed the educational and vocational boats badly. For example, the highest-scoring enlisted man in our Corsican bomber command headquarters was a 30-year-old high-school graduate who in civilian life had been a postal clerk. On the AGCT he scored far above a Yale University Ph.D. and a New York lawyer in the group. It occurred to me vaguely that, to update Thomas Gray's immortal words, "Full many a brilliant person will not have his or her abilities recognized and nurtured." What if these persons' high scores had been known earlier and used as a basis for maximizing the utilization of their abilities? I resolved--rather dimly at that time, to be sure--to do something about this presumed wastage of talent.

Later Illustrations

Four years of graduate study and teaching at Harvard University under the G.I. Bill brought contacts with Truman Kelley, Phillip Rulon, Walter Dearborn, Frederick Davis, and others that professionalized my interests in intellectual giftedness as revealed by tests. I left there in 1949 to be the specialist in psychological statistics, measurement, experimental design, and research methodology at the George Peabody College for Teachers and part-time at Vanderbilt University across the street. As if this variegated assignment weren't enough, I was also in charge of all testing at every level at Peabody: American Council on Education Psychological Examination and other instruments for incoming freshmen, Miller Analogies Test for graduate students, etc.

In addition, I was shepherd to an IBM electric (not electronic) test-scoring machine that was used to score objective tests and examinations for any professors who requested that service. It was this temperamental, balky, clumsy machine that led to my first major postdoctoral discovery of academic talent, serendipitous rather than planned. A professor who tended to attract only the most mediocre students to his classes had tested them with the ACE Psychological Exam. As my two scorers expected, the scores ran quite low, but one student's stood out glaringly because they were so much higher than the others, and practically perfect. The scorers suspected that this aberrant student may have had a scoring key. I glanced at her name and realized that she was a young women who dozed in the back of my large, very elementary statistics course. Apparently, she was exceptionally able, and bored. I found her down the hall doing some hunt-and-peck typing for a professor of elementary education. She was in the process of divorcing her husband, and at loose ends. Having been graduated from college with high honors in English and mathematics at age 18 and having taught for five years in high school, she was now floundering around in a general Master's degree program in education with no definite goal in mind. The two scores alerted us to her potential, however, so by the end of the year she had a Master's degree in psychology and went on to obtain the Ph.D. degree in experimental psychology with honors at a large state university. Today she is one of the leading administrators in the testing field.

Over the years I continued this process, both serendititously and deliberately. For example, in the summer of 1956 I tried out the recently published Terman Concept Mastery Test on the 83 students in a large graduate educational psychology course at the University of Wisconsin. Total scores ranged from a shocking low of 11 points out of the possible 190 to a high of 169. Terman's "geniuses" who had earned Ph.D. degrees averaged 159 at age 40, so 169 was indeed a very impressive score. I talked with the young man and discovered that he had been graduated from the University of Wisconsin with high honors and election to Phi Beta Kappa. Then he had taken a Master's degree in comparative literature but did not impress his hard-to-please major professor favorably enough to go on toward the doctorate. He was "retreading" to become a junior-high-school teacher of English. We helped him get university fellowships for three years and earn a Ph.D. degree in measurement. Nine years after taking the CMT test he was a full professor at a top-level university.

Though most of the high test scorers went on to become quite successful, a few did not. One of the brightest I've found was an underachiever as an undergraduate and continued to be so in the doctoral program and thereafter, though in his first graduate year he did some astonishingly brilliant research. In the language of clinical psychology, however, he seemed to have a serious academic character disorder--mental ability without much mental energy.

Test scores can serve as useful antidotes to personality defects that make a person seem less bright than he or she really is. For example, a young man who scored 94 out of 100 points on the Miller Analogies Test and 49 out of 50 points on the Doppelt Mathematical Reasoning Test, even though he had little background in mathematics, was thought by a famed quantitative specialist to be rather dull intellectually because he was somewhat rigid and contentious. When encouraged to pursue a doctoral program, however, he quickly did important, original research that made his name widely known before he received the Ph.D. degree. Nothing in his academic background itself or recommendations indicated how able he was. The test scores furnished the needed clue.

Our First "Radical Accelerate"

It would be possible to continue in this vein for the rest of my time here, but instead I'd like to move on to more systematic use of test information in our Study of Mathematically and Scientifically Precocious Youth. We have leaned very heavily on test scores in this project, and with results so good they surprised even me. Leading up to the funding of the Study by the Spencer Foundation was my testing experience in early 1969 with Joseph L. Bates, a 13-year-old eighth grader who during the summer of 1968 had taken a special computer course at Johns Hopkins. He was so startingly precocious that the instructor of that course called him to my attention.

Joseph's scores on college-level and graduate-level tests, including College Board ones and the Doppelt Mathematical Reasoning Test, were so strikingly high that finally, for want of a better alternative, I had him admitted to Johns Hopkins in the fall of 1969 while he was still 13 years old to take honors calculus, sophomore general physics; and introduction to computer science. On that 13-semester-hour load of difficult courses he made a grade of A in both physics and computer science, ranking near the top of the large class in the latter, and a high B in honors calculus. His grade-point average was 3.69, where 4 is straight A. Joseph went on to earn the B.A. degree in quantitative studies in May of 1973 and the M.S. degree in computer science three months later. This fall he begins work toward the Ph.D. degree in computer science at Cornell University on a university fellowship while not yet 18 years old. Without that testing four years ago he would probably be a college freshman this fall. The thought of that stultifying possibility makes him and his parents pale.

Another Skips Four Years, A Third Only Two

But one radical-accelerate swallow does not make an academic spring. For all we knew, Joseph was the only person in the country who could skip four years of college profitably! The finding needed replication. By an improbable coincidence this was obtained the next year (while Joseph was a sophomore) because the parents of another precocious eighth grader happened to hear of Joseph. They urged me to admit him in the fall of 1970, and eventually I did, after ascertaining that on test scores he was virtually Joseph's twin. (They were quite different in personality, however.) This young man, Jonathan M. Edwards, was 13 years old until November of his freshman year. This fall he will be a senior at Johns Hopkins, majoring in philosophy and mathematics. His first-semester GPA was 3.75, and he has continued to do well.

Then we skipped a year and last fall admitted at the end of the tenth grade Jeffrey N. Rottman, who had written me about his academic dilemma. Jeff completed the freshman year with high A's on all his 40 credits. He proved to be so vastly overqualified even for difficult Johns Hopkins that I helped him transfer to a more difficult college. Clearly, he was academically ready to enter college two years earlier.

Next fall two 14-year-olds are scheduled to enter, each with four or five college courses already completed while in high school. In the fall of 1974 and thereafter we shall probably have half a dozen or more students each fall who begin several years early. They will live at home, at least during the freshman year, and take initially whatever courses they can probably do best--typically, during the first semester, honors calculus, physics, and chemistry or computer science.

SMSPY Begins

The experiences with Joseph and Jonathan emboldened me to apply to the newly created Spencer Foundation and get a five-year grant, beginning 1 September 1971, to study extreme mathematical and scientific precocity systematically. We began with a nominations system, but it yielded too few seventh, eighth, and underage ninth graders at the high level we desired, roughly the upper one-half of one percent of the age group. Therefore, in March of 1972 we launched a talent-search test competition, and conducted it again in January of 1973.

The first year we administered the Scholastic Aptitude Test, Mathematical part, and the Mathematics I (i.e., lower level) Achievement Test of the College Entrance Examination Board to all mathematics competitors, and the Sequential Tests of Educational Progress (STEP) Science, Level 1, Forms A and B, to all science competitors. Examinees were in the seventh or eighth grade, or, if in a higher grade, not yet 14 years old. Two hundred fifty-eight boys and girls took the two math tests only, 54 took the two science tests only, and 138 took both. They were meant to be drawn from the upper 5% of the age group, and probably most of those who came after seeing the practice materials were in the upper two or three percent. Many of the scores were gratifyingly high. For example, of the 396 who took the math tests, 22 scored at least 660 on SAT-M, which is higher than the average Johns Hopkins freshman scored when he was a high-school junior or senior; one 13-year-old boy scored 790. In fact, 10% of all the 223 male math entrants scored 660 or more. There was an unexpected sex difference: none of the 173 girls scored more than 600 on SAT-M, and 43 of the boys (19%) scored higher on that test than any girl did.

The results for science were similarly high. One seventh-grade boy scored 137 points out of a possible 150, which is the 99th percentile of college sophomores tested in the spring. Twenty-two of the 129 boys (17%) exceeded the top-scoring one of the 63 girls. We do not know _why_ the top-scoring boys exceeded the top-scoring girls so greatly on both tests. Descriptively, this seems to mean that, while 12-13 year old girls are often extremely good mathematics or science students in their school grade (competing well with boys there), they are not learning outside of class enough of these subjects to score high on _college-level_ tests. In a sense, they are as "smart" as the boys but not as precocious in mathematics or science as the best boys. Helen Astin and Lynn Fox are investigating sex differences in these subjects and trying systematically to eliminate or minimize them. See Astin (in press) and Fox (in preparation).

A Larger Competition the Second Year

The competition in 1972 attracted entrants mainly from the greater Baltimore area. In 1973 we went farther afield, to the whole state and especially to talent-rich Montgomery County north of the District of Columbia.

Only the Scholastic Aptitude Test was used, but both parts (mathematical and verbal) were administered. We had decided from the first year's experience that it was better to locate the excellent mathematics reasoners in the general competition and to test them later for knowledge of general science. Scores ranged from 210 to 740 on verbal and 210 to 800 on mathematical. Thirty-seven of the 537 boys (7%) scored at least 660 on SAT-M, and two (one of them a seventh grader) earned 800's. The reduction from 10% in 1972 to 7% in 1973 probably resulted partly from the fact that two competitions (verbal and mathematical) were run in 1973 but not in the preceding year. Some of the high scorers on SAT-M came from the verbal competition.[1] One of the 416 girls earned a score of 650 on SAT-M, so only 7 percent of the boys exceeded the top girl, vs. 19% in 1972. Better publicity and wider searching seemed to produce more female mathematical talent, but even then 37 boys exceeded the top-scoring girl on this difficult test.

As might be expected, we have found our math-competition groups somewhat more precocious on the mathematical part of the SAT than on its verbal sections, but the difference is not dramatic. Few who score high on SAT-M fail to score high on SAT-V also, though usually not quite as high in terms of percentile rank of high-school seniors. There is no <u>idiot savant</u> among the high SAT-M scorers. For example, the 35 top boys in 1972 averaged 660 (95%ile of high-school seniors) on SAT-M and 546 (87%ile of high-school seniors) on SAT-V when administered to them a month later. Only one verbal score was below 400, whereas 390 is the median of high-school seniors. One was 740, compared with Johns Hopkins' average of 613.

This sketchy background of material reported more fully elsewhere (Stanley, Fox, and Keating, 1972; Keating and Stanley, 1972; Stanley, Keating, and Fox, in press; Denham, 1973; Fox, 1973; Keating, 1973) is meant as further evidence concerning the first two of the three themes set forth earlier in this paper. We discovered youths with great mathematical reasoning ability, studied them much more fully via several additional days of testing with high-level instruments, and then facilitated their educational development. Some of them skipped one or more grades in school, some entered college early, many took college courses for credit on a part-time basis, and quite a few had their mathematical development markedly accelerated in three special classes that we set up. Of course, a few chose not to do anything unusual at the time, but all of the 71 highest scorers received considerable educational counseling personally, by telephone, and via a monthly newsletter.

Skipping Grades

We judged that any of the 71 were academically ready to skip one or more school grades. Much depends on how strongly the boy or girl wants to move ahead. Thus far, many of the boys--but few of the girls--have chosen this route. Two boys skipped from sixth to eighth to tenth grade. The older of these intends to enter Johns Hopkins as a full-time student at the end of the tenth grade. He has already taken three college courses (computer science in the Johns Hopkins day school at age 13, earning an "A," and set theory and principles of economics at another local college). Another boy, the top math scorer in the first competition, has skipped the eighth and tenth grades. Several boys have skipped the ninth grade of the junior high school in order to get into a senior high school where courses are more appropriately difficult--often, to take twelfth-grade honors Advanced Placement calculus. All who have skipped report good personal adjustment and no appreciable academic difficulties. At least two have won the mathematics contest in their high school while still under-age tenth graders. Most of, them plan to enter college early by completing high school in two years or simply leaving at the end of the eleventh grade.

Becoming Full-Time Freshmen Early

Early entrance to college has already been discussed. As our high scorers approach the tenth grade, we expect many of them to make plans to cut at least one year, and quite often two or more years, off their high-school programs. Already a number of them are planning this with us and with school personnel. Most of the boys will come to Johns Hopkins for the first year, at least, because the university is prepared to admit them and provide financial aid, if needed. Some of the girls will perhaps attend nearby Goucher College, which has a long history of early admission. Our working hypothesis is that a youngster is ready to enter Johns Hopkins early when his College Board scores are in the upper fourth of its distribution, and provided that he or she is <u>eager</u> to come. Parental zeal is not sufficient.

Johns Hopkins has Master's degree programs in various areas that are concurrent with the Bachelor's. That is, without taking an extra number of courses but by including a considerable number of graduate-level courses in the schedule, a student may receive the Bachelor of Arts or Bachelor of Engineering Science along with the Master of Arts or Master of Science in four years at no extra cost. These are not easy programs, of course, but our first radical accelerate, Joseph Bates, found the B.A.-M.S. route feasible. He had to prepare a thesis but was not required to demonstrate reading knowledge of a foreign language, as would be necessary for the M.A. degree. We expect that many of the radical accelerates, particularly those who have financial problems, will save another year or two in this manner.

College Courses on Part-Time Basis

One of our most interesting innovations has been college courses for credit at a wide variety of institutions for these mathematically able youths. About 30 students thus far have taken from one to six courses each, most of them with grades of A and none below B. The favorite is introduction to computer science. Also popular are college algebra and trigonometry (a 10-year-old boy just out of the fourth grade made a B on it in the Johns Hopkins Evening College this summer) and analytic geometry. Other courses taken include chemistry, Russian, set theory, economics, calculus, and English composition. As the Study continues, the variety will increase.

Saturday Morning Class

In the summer of 1972, Daniel Keating and I rather hastily set up a special course in mathematics, chiefly for students who had completed the sixth grade. We did this to test our notion that test scores are powerful indicants of readiness to move ahead fast in algebra, plane geometry, trigonometry, and analytic geometry. We had rather suddenly discovered a superb teacher, a reformed physicist with zeal to produce mathematical prodigies. (This remarkable fellow, Joseph Wolfson, also likes to work with difficult learners.) Our population consisted of 30 boys and girls who while in the sixth grade recently had scored at the 99th percentile on the Academic Promise Test Number subtest and also at the 99th percentile on either the APT Verbal subtest <u>or</u> the APT Abstract Reasoning (nonverbal) subtest. We fudged a bit by inviting the boy in this group who scored 16 points above the minimum 99th percentile on N, even though he was a couple of points short of the 99th percentile on both V and AR. Also, we took into the group a boy who had completed the eighth grade and Algebra I and was skipping to the tenth, because the college course he had planned to take was canceled. A third exception was a brilliant nine-year-old boy who had completed only the third grade.

Of the 30 who were invited to begin fast-paced study two hours each Saturday morning, starting June 24, 21 accepted. Nineteen of these freed themselves from summer vacations sufficiently to complete the first nine weeks, though not without absences; one attended only 10 hours, i.e., just 55% of the class time. Then we administered Form A of the Cooperative Test of Mathematics, Algebra I, to these 19 persons, 18 of whom had studied algebra rather informally for a maximum of 18 hours. All but four scored at the 60th-99th percentile of ninth graders nationally who have studied algebra five days per week for a school year. A girl who had attended only 12 hours scored at the 97th percentile, as did the boy with the high APT-N score who had not quite qualified on V and NR. The nine-year-old boy scored at the 93rd percentile.

This seems a remarkable result for a maximum of 18 hours of instruction, versus the 135 hours or more that are devoted to Algebra I in the typical high-school class. What had we known about these students in order to pick them so well?

1. The APT testing was done with the "ten top students" in each of 40 Baltimore County elementary schools. Teachers had been asked to consult their test files and nominate the highest scorers, but of course classroom excellence probably played a considerable part in the selection. Some "slippage" occurred because testing was conducted throughout the school year and no adjustment in scores was made for this.

2. We knew each student's sex and school attended, but made no use of these in deciding whom to invite.

3. We knew nothing at all about the invitee's school success, parents' education, socioeconomic status, or interest in mathematics, other than was reflected in the teachers' nominations for testing and the students' choosing to enroll for the summer course. Most who chose not to enroll, however, seemed to have vacation or transportation problems, rather than motivational ones. The students and their parents knew little about us, except that we were based at prestigious--and medically formidable--Johns Hopkins in a department of psychology operating under the title of "Study of Mathematically and Scientifically Precocious Youth."

Thus we were relying largely on the APT scores, collected by several undergraduates as a testing-course project. Later we noted that the APT-N is a composite of arithmetical reasoning and arithmetical fundamentals, whereas we desired mostly the former. This weakened our selection somewhat, so for later special groups we have used the SAT-M instead.

The Importance of IQ Re-rediscovered

Thus we demonstrated anew the well-known but seldom-used fact that mathematically bright youngsters can learn Algebra I better in far less than the usual time devoted to it. We also noticed that on a difficult verbal test five of the six lowest scorers on the algebra test had scored lower than any of the other students except the nine-year-old. (The sixth was a bright trouble-maker who did little homework and attended the least of anyone.) We immediately recalled Quinn McNemar's (1964) APA presidential address entitled "Lost: Our Intelligence? Why?" For children approximately the same age, chiefly 12 years old, score on the School and College Ability Test, Level 1C (appropriate for admitted college students), is a measure of developed intelligence. Hence, like the IQ it is an index of learning rate for absorbing the course material fast and for answering 40 different items on the algebra test in 40 minutes. The APT-V did not show this up as well, but even there three of the bottom four algebra scorers had the lowest APT-V scores of anyone in the group, and the fourth was the bright absentee mentioned above.

It appears that Abstract Reasoning, somewhat similar to what the Raven Progressive Matrices measure, cannot suitably substitute in this situation for a high verbal score. You will recall that we allowed it to do so. Fast learning seems to demand a reasonably high verbal IQ, measured on a difficult test.

But other qualities are important also; two boys of only moderately high verbal ability kept up the pace well for 14 months. One of them, at age 13, this summer made A in the introduction to computer science course at Johns Hopkins and A in an analytic geometry course at a state college. The other plans to skip the eighth grade and take advanced subjects in a senior high school next fall, also at age 13.

The Highly Successful Ten vs. the Successful Six

The five lowest scorers on the algebra test dropped out of the Saturday morning class at the end of the summer, as did the close friend of one of these, who had herself scored a little higher. This left 13 persons, to whom that fall (1972) we added two eighth graders and a seventh grader, none of whom had studied algebra in school but who on their own had learned a considerable amount of it. These 16 (9 boys, 7 girls) persisted into the summer of 1973. Ten of them kept up well with the fast pace that Mr. Wolfson set in Algebra II, Algebra III, trigonometry, plane geometry, and analytic geometry. The other six were assigned another instructor to help them in self-paced fashion. They completed Algebra II while seventh graders, whereas that subject is rarely available until the ninth or tenth grade.

All seven of the boys from Mr. Wolfson's fast-paced section plan to take calculus or probability and statistics this fall. None of its three girls do. Also, seven of the nine boys skipped a grade last fall and/or will do so this fall, and most of them will also take college courses part-time and enter college early, thus illustrating the interactive effects of the various accelerating devices--particularly the special class.

Within the group of 16 persons it is difficult to differentiate the highly successful 10 from the "merely" successful 6 by test criteria. The girl and the boy with the highest SAT-V score for their sex among the ex-sixth graders were in the six, but so were the boy with the lowest verbal ability and a girl with the lowest SAT-M score of the 16. Also, leading the six was a seventh grader who entered the class in the fall without enough background in Algebra I and could not catch up to the fast group and a girl who had scored quite high on the Algebra I test at the end of the summer.

Importance of Attendance, Homework, and Parental Attitude

Obvious factors separating the two groups were class attendance and homework. The bright boy attended poorly and did not bother to keep up with the work. He appeared preoccupied mainly with the church, scouting, and military history. His mother, who had not attended college, seemed to make little effort to get him to class well prepared. Contrasted with him, in the highly successful group there were three less-able persons, a boy and two girls, whose intrinsic motivation seemed slight but whose parents insisted that they do homework regularly and carefully and attend class each week.

The bright girl in the less successful group was especially interesting because, even though both of her parents are college graduates, she never did homework well, if at all. Apparently, she is so apt that school work is easy for her and therefore she is an "A" student in her seventh-grade subjects, but given further competition she will not increase her efforts. This seems to be what I referred to earlier as mental ability without sufficient mental energy to use it fully. We never could detect any signs that she is likely to change. Three different teachers, one of them female, were equally unsuccessful with her.

The Saturday morning class proved our point, that high-aptitude youngsters could learn far more mathematics quicker and better than they do in school. Not all such persons identified mainly by a few test scores will succeed well in a given special class, of course. We regret that the early dropouts from such a course will probably consist heavily of children from the lower socio-economic levels in the group--especially, it would seem, those who have mothers who did not attend college. This is confounded somewhat by the tendency of such children not to score as well verbally as children of better-educated parents do.

Just two of the six dropouts were female, but only three of the seven remaining girls stayed in the fast group, whereas seven of the nine boys did. Only one of the girls seemed to have as strong interest in mathematics *per se* as most of the boys had. The girls seemed to value the social experience of the class more than its theoretical orientation and (all but one) to shrink from mathematical competition with the boys.

Mr. Wolfson's New "Super-class"

During the summer of 1973 Mr. Wolfson started another special class consisting of 31 persons, nearly all of whom will be ninth graders this fall. In the 1973 competition, each of these scored at least 400 on SAT-V and 500 on SAT-M, and later demonstrated good knowledge of Algebra I on a standardized test. Thirty of these (22 boys and 8 girls) completed two 1 1/2-hour sessions per week for eight weeks, studying Algebra II. Most of them will continue in the fall, two hours per week with Mr. Wolfson in lieu of studying mathematics in high school. They will cover Algebra III, plane geometry, trigonometry, and analytic geometry thoroughly. By the fall of 1974, when they will be tenth graders, the successful persisters should be ready to enroll for honors Advanced Placement calculus, a twelfth-grade subject. This is an initially older and higher-level group than the original Saturday morning class. It will be fascinating to see how they progress during the coming school year and thereafter. Of course, some of them are already planning to skip grades, take college courses part-time, and enter college early.

Mrs. Fox is working with an all-girl group of somewhat lower ability than Mr. Wolfson's. Her success with them during the summer of 1973 was highly impressive. It will be illuminating to see how well they do in Algebra II in school as eighth graders this fall.

For the rationale of our special educational efforts and for further details, see Fox (in press, Chs. 3 and 6).

Conclusion

This paper has been an informal attempt to illustrate the great value of standardized tests for locating talent that otherwise is likely to remain submerged and unidentified. The tests used must be appropriate to the actual ability level of the persons tested. Often that will mean using college tests with children below the senior high school level. Only via such instruments can sufficient ceiling be obtained and can the power of the examinee's mind be probed adequately.

The goals of our Study are three-fold; discovery, description, and development. As we use the word "development" in this context, it means vigorous intervention in the educational process on behalf of the highly talented student. We try not to obstruct or frustrate the school system, but instead to augment its usual functions. Identification of talent, study of talent, and intervention to facilitate it are aided greatly by appropriately difficult tests of important aspects of mental development.

Critics of testing who allege that instruments such as the SAT serve mainly to discriminate against low scorers do not take into account fully enough the talent-finding aspect. This is particularly important in so-called disadvantaged groups, where persistent, careful testing is needed to discover general and special abilities that can be capitalized on in the educational process. It is equally important, or more so, for locating abilities that have developed to a high level early. If school personnel would study their test records and supplement them with additional harder tests, as needed, top-ability students could be provided for much better than is usually done at present. This calls for more dedication and daring than money. In fact, the methods that we use and recommend for intellectually gifted youths can cut total educational costs greatly for parents and appreciably for school systems.

We conducting the Study have at least three more years in which to strengthen our findings, provide workable prototypes, and promulgate them. My associates and I would welcome your comments, criticisms, and suggestions. Building on the pioneering work of the late Lewis M. Terman and his Genetic Studies of Genius, we feel keenly that much of the gifted-child research movement was buried with him in 1956. Great potential mental energy lies waiting to be made kinetic.

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Footnotes

*Presidential address to Division 5 (Evaluation and Measurement) of the American Psychological Association on 27 August 1973 at its annual meeting in Montreal, Canada. I thank the Spencer Foundation for financial support that made this work possible and my project associates (Susanne A. Denham, Lynn H. Fox, and Daniel P. Keating and William C. George) for their contributions to the Study thus far.

[1] The Study of Verbally Gifted Youth, funded by the Spencer Foundation for the period 1 September 1972 - 31 August 1977, is conducted at The Johns Hopkins University by Robert Hogan, Katherine Garvey, and Roger Webb. On 27 January 1973, 666 persons were tested in the mathematics competition. On 3 February 1973, 287 were tested in the verbal competition. Most of those who came on January 27 were more interested in mathematics than in the verbal area, whereas the opposite was true of the February 3 group. Nevertheless, of the 37 boys who scored at least 660 on SAT-M, five were tested in the so-called verbal competition. Similarly, the two highest verbal scores (710 and 740, earned by boys) occurred on January 27. But in every sex and grade category the January group scored higher on SAT-M than did the February group, and the opposite was true for SAT-V. The overall means were 516 vs. 442 for SAT-M, and 417 vs. 445 for SAT-V. The 74-point difference for M greatly exceeds the 28-point difference for V, so apparently the mathematically oriented youngsters knew their abilities rather well and were not handicapped verbally. A possible source of confounding should be noted, however: for motivational reasons, in January SAT-M was administered first, whereas in February SAT-V came first.