content area teachers can use.

Herber relies heavily upon unpublished doctoral dissertations for his data sources. In his Preface he acknowledges that he has had a group of doctoral students conduct interrelated dissertations in the area of content reading. I applaud this technique. Seldom does a single study offer much direction, but linked studies offer an opportunity to establish a base of data which can show strong directions.

Back to his chapters on comprehension. In Chapter 3, "Levels of Comprehension," Herber identifies three levels: literal, interpretive, and applied. Here I started to quarrel with Herber. The word level implies hierarchy to me and the data is not in to substantiate comprehension hierarchies. Then on page 58 and again on page 61 he suggests to teachers that there should be variations in the applications of levels of comprehension. He even claims that there are no data to indicate which level teachers should start instruction. He suggests the order of instruction might have to do with student preference or teacher preference. And the quarrel was over.

Throughout the book, but especially in the chapters on comprehension, Herber has the reader doing exercises that require the reader do what Herber is suggesting they teach. Excellent! At first these exercises seemed to interrupt the flow of the content that he was delivering, but it quickly became clear that they were essential in making his points. And the exercises came from a variety of content areas such as music, science, social studies, and English, as are almost all of them here acknowledged by Herber.

Another feature of the book struck me as noteworthy. Herber continues to express the need for considering alternatives. He makes suggestions and then supplies alternatives, leaving the content teacher with some decisions to make. Perhaps more importantly, the book leaves one with the feeling that there are a variety of ways to approach teaching reading in content areas, not that there is one right way.

Chapters 8 and 9 carry specific instructional and organizational strategies. Each of these strategies place the emphasis on learning and away from management ease. For example, in his first edition, Herber suggested homogeneous grouping within a classroom. In this edition he admits to that mistake and makes many practical suggestions in favor of random grouping. He also makes a strong and practical case against assumptive teaching in these chapters.

Chapter 10 deals with assessment. Herber calls for a decrease in the amount of formal testing done in schools and makes suggestions for the use of informal techniques. I am in complete agreement. Then, on page 238 he includes a short paragraph on the importance of standardized tests, claiming them to be useful, reliable and valid. With the amount of mixed reaction in the literature concerning the use of standardized tests, I believe this short paragraph is inappropriate. With that exception, however, the chapter on assessment should be extremely helpful to content area teachers.

The book concludes with three Appendices. One on reference materials, one on instructional materials, and a Bibliography. I should think content area teachers would be especially interested in the second one, Sample Instructional Materials.

In all, Herber's book is a thorough revision, well updated, with very specific suggestions, and is a unique contribution to help content teachers offer better learning opportunities for their students.

Julian C. Stanley, William C. George, and Cecilia H. Solano (Eds.), ***The Gifted and the Creative: A Fifty-Year Perspective.*** Baltimore, Md.: The Johns Hopkins University Press, 1977. 284 + xiv pp. $4.95 paperbound, $17.50 hardcover.

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Mathematics Education

This book has much to offer to nearly everyone, whether they are interested in the education and careers of gifted students, or are completely uninterested in gifted students. From a cognitive point of view, problem-solving processes in most students surely build upon the same basic information-handling capabilities used by the gifted; from a methodological point of view the kind of understanding that Stanley seeks, and the ways he seeks it, are of general interest; and from the point of view of analyzing and improving school programs, Stanley's work raises questions that are important for every recognizable sub-group of students.

The Gifted and the Creative reports on a symposium honoring Lewis M. Terman, held at Johns Hopkins in November 1975. Given this orientation, the volume deserves its subtitle, *A Fifty-Year Perspective;* it has three main sections, the first dealing with an historical analysis of the gifted-child movement, the second offering an account of the first five years of Stanley's Study of Mathematically Precocious Youth (SMPY), and the third reviewing several approaches to the definition and study of "creativity." But let there be no mistake—the main interest in this volume arises unmistakeably from its association with Stanley's on-going intervention in the education of the mathematically precocious, the SMPY, which was started in 1971, and is projected to continue at least until the beginning of the 21st Century.

Julian Stanley is beyond question an interesting man. Originally a teacher of science and mathematics in high school, he is best known to most researchers for his publications in the area of measurement and research design. At present he is a professor of psychology at Johns Hopkins ("psychology," and not, as he explicitly points out, "educational psychology"). He is given to direct communications and direct action: a scholar, deeply interested in understanding giftedness, he expects his work to offer immediate advantage to gifted students. Although now to some extent identified with studies of the gifted, he has in the past been equally active on behalf of the disadvantaged, and (in conjunction with Lynn Fox) has played a role in initiating the current interest in male-female differences in mathematical performance.

From 1969 through 1975, SMPY had studied—and intervened in the lives of—3,000 mathematically talented boys and girls. The typical point of contact between SMPY and a prospective student is an invitation to take an exceedingly difficult exam in mathematics—The College Entrance Examination Board's Scholastic Aptitude Test SAT-M, which is intended for twelfth graders, but which SMPY usually administers to seventh or eighth graders. This is primarily a test of great strength in mathematical *reasoning*. Stanley rejects the use of *computational* tests as too mundane to reveal the abilities he seeks, and he rejects I.Q. tests as too general. He is specifically seeking *mathematical* ability, in the sense in which mathematicians usually recognize it.

Those who take the test come, Stanley believes, from the upper 1½ percent of their age group; for some aspects of its work, SMPY deals with the top one-tenth of one percent. The study is officially conducted statewide across Maryland, but students living elsewhere seem to get included on occasion.

Stanley means to go to extremes. SMPY's students include Eric Robert Jablow, who received his B.S. degree in mathematics from Brooklyn College when he was 15 years old, and who, in the autumn of 1977 was enrolled as a doctoral student in mathematics at Princeton University—possibly the most sophisticated doctoral program in the United States. In autumn 1977, Jablow's chronological age was 15 years, 6 months. Other students show similar patterns:

> At age ten one of SMPY's participants made the highest grade in a state college introduction-to-computer-science course, competing with seven of our exceptionally able older students and twelve adults. Before his eleventh birthday he completed at Johns Hopkins most of a second-level computer course on which he earned a final grade of A. At age eleven he earned, by examination, credit for two semesters of the calculus at Johns Hopkins. This is no ordinary boy, of course. His Stanford-Binet IQ at age eight was 190, and he had been in our special fast-mathematics classes for two years. Even he is not the most precocious youth we have discovered. Furthermore, at age twelve to thirteen, when the typical child is in the seventh or eighth grade, there are quite a few students able to forge through all of precalculus mathematics *far* quicker than schools ordinarily permit them to do.

Stanley clearly believes that typical school programs do not well serve those who are gifted in mathematics. SMPY has accumulated many instances where schools have seemed to fail to acknowledge a student's actual level of mathematical functioning, or have been unable to deal appropriately with students. One typical example:

> A twelve-year-old seventh grader who scored extremely high in one of SMPY's annual contests asked permission to join his junior high school's eigth-grade algebra I class in February but was refused on the grounds that he already had missed more than half the course. He insisted on being given a standardized test covering the first year of the subject. On this he made a perfect score, 40 right in forty minutes, which is two points about the 99.5th percentile of national norms for ninth-grade students who have been in this type of class all year. Upon seeing this achievement, the teacher agreed with the boy that he was indeed ready to join the class! Instead, he took a college mathematics course that summer and easily earned a final grade of A.

Perhaps even more revealing is the tone of Stanley's discussions of how schools do deal with the gifted, as in this passage:

> . . .the usual high school pace in Algebra I to III, geometry, trigonometry, analytic geometry, and the calculus is far from optimum for boys and girls who reason extremely well mathematically. Algebra I is a particularly virulent culprit, because being incarcerated in it for a whole year gives the apt student no really appropriate way to behave. He or she can daydream, be excessively meticulous in order to get perfect grades, harass the teacher, show off knowledge arrogantly in the class, or be truant. There is, however, no suitable way to while away the class hours when one already knows much of the material and can learn the rest almost instantaneously as it is first presented. Boredom, frustration and habits of gross inattention are almost sure to result.
>
> We were amazed that even more youths do not sustain obvious academic injury, and we suspect that the damage is greater than it seems.

After a student has been identified, what does SMPY do? Essentially two things: they make available an extensive program of counseling, and they provide special rapidly-paced mathematics courses that meet Saturdays, or summers, or otherwise avoid conflicts with usual school schedules. Increasingly, they rely on tutoring by slightly older students. These courses do not make up the major part of the intervention. Instead, every effort is made to enroll the student in existing high school or college courses. The special rapidly-paced courses are used only where no other arrangement seems feasible, and then only relatively briefly, although SMPY reports that sharply focussed tutoring is proving to be the best approach. The "sharp-focussing" is achieved partly by a careful use of testing; tutoring is then aimed at learning *precisely those points* that a student has missed on a pretest. At this point, SMPY resembles cognitive studies on mathematics learning, or at least makes contact with them.

SMPY is NOT a "curriculum development" project in the usual sense; it is primarily a counseling project. A typical result looks like this:

> At the end of the sixth grade a student took second-year algebra in summer school without having had first-year algebra; his final grade was A. By the end of the eighth grade he had earned credit by examination for two semesters of college calculus. A year later he had completed third-semester calculus by correspondence from a major university, earning A as his final grade.

Stanley's view of what schools typically do for gifted students, and what can instead be done, can be inferred from passages such as this:

> *Busy work* is a well-known way for some teachers to keep their brightest students occupied while the class goes on with its regular

work. In a common form it consists of having them do a great deal more of the subject in which they are already superb, but at the same level as the class they have surpassed. One of our eighth graders, whose Stanford-Binet was 187, was asked by his algebra teacher to work every problem in the book, rather than just the alternate problems that the rest of the class was assigned. He already knew Algebra I rather well and therefore needed to work few problems, so he resented this burdensome chore. The busy work proved to be a powerful motivator, however, because after that year he took all of his mathematics at the college level. First, though, during the second semester of the eighth grade and while he was still twelve years old this precocious youth took the regular introductory course in computer science at Johns Hopkins and earned a final grade of A. During the summer, still twelve until July, he took a course in college algebra and trigonometry at Johns Hopkins, earning a B. From then on for two academic years and two more summers he took college mathematics through the calculus and linear algebra and two years of college chemistry with all A's. At age 15 1/6 years he entered Johns Hopkins as a full-time student with 30 percent of the sophomore year completed. Ducing his first year at Hopkins he earned eight A's and one B on difficult courses, majoring in electrical engineering. Thus in a rather perverse sense his teacher had done him a great favor, but without his having been discovered by SMPY, he would probably have been forced to sit a whole year in each of numerous high-school mathematics courses far below his capabilities.

In May 1976 this remarkable young man completed his junior year at Johns Hopkins with an impressive record in both his studies and research. On his sixteenth birthday, July 10, 1975, he had begun work for the summer with General Electric. During the summer of 1976, while still sixteen, he was a full-time researcher at the Bell Telephone Laboratories. He is scheduled to receive a baccalaureate from Johns Hopkins a couple of months before his eighteenth birthday—that is, four years ahead of the usual age-in-grade progression—and continue on to earn a Ph.D. degree in electrical engineering by age twenty or twenty-one. Radical educational acceleration is certainly paying off well for him—academically, professionally, and personally. In March 1977 he was awarded a three-year National Science Foundation graduate fellowship to study electrical engineering at the Massachusetts Institute of Technology.

SMPY reports that self-pacing is usually unsuitable for gifted students, since it deprives them of the stimulation of their intellectual peers. Similarly, programmed instructional materials are too unchallenging.

By no means the least interesting aspect of SMPY is its method of contacting subjects. Quite surprisingly, it does not contact schools, nor does it contact parents:

> From its inception SMPY has tried to communicate directly with the youths themselves, rather than through their parents. Reports of the results of the testing competition have gone to them, even including discussion of percentile ranks on national norms and the like. We have also written letters to them in response to their queries or their parents'. In the few instances where we have deviated from this policy—chiefly, with quite young boys and girls who came to our attention by way of their parents rather than through the formal talent search—the youngster's motivation has seemed to suffer. We believe that contacts of the facilitating agency such as SMPY should be mainly through the youth, even though he or she may be only nine or ten years old. After all, a child that age whose Stanford-Binet IQ is 170 or more (and SMPY seldom deals with any that young unless they are that bright) has a mental age of at least fifteen years. He or she will be as able to understand our communications as many parents are. We want the youth to take charge of their own academic planning early and to use their parents and us as means for implementing their own decisions. Some parents object to this approach, of course, because they want to keep their children dependent, but if communication from the beginning is with the student, such friction between SMPY and the parents will not usually be great.

In this sense, SMPY represents part of the consumer movement, applied to the case of education.

The intervention aspect of SMPY is well summarized as:

> . . .the SMPY staff believes that offering each splendid mathematical reasoner a varied assortment of accelerative possibilities and letting him or her choose an optimum combination of these to suit the individual's situation is far superior to so-called special academic enrichment. Of course, we would be pleased to see individual courses and curricula improved and special accelerative classes set up by school systems for their intellectually talented students.

So much for intervention; where is the *research*? For one thing, of course, the research lies in the longitudinal study, projected to last at least into the twenty-first century. Stanley has carefully studied the general popular hostility to precocity and extreme acceleration. He has written extensively of the lack of factual basis for most fears and prejudices. Precocious and radically accelerated students do NOT suffer in the long run—study of actual cases reveals quite the opposite. Biased selection can focus on prodigies who subsequently fare poorly, but such cases are NOT representative; the truth lies in the opposite direction: prodigies tend to fare substantially better than the population at large, as unbiased studies clearly show, and radical acceleration is nearly always beneficial, not harmful. By the year 2000 the SMPY studies should demonstrate this even more conclusively.

There are a great many subtle aspects to the research, as well. But what is most characteristic is the deliberate and well-thought-out combination of study and intervention. All researchers would be well-advised to reflect on this. Surely medical research is supported because the public values the eradication of polio and looks forward to the eradication of cancer, heart disease, and the common cold. How long will education research be supported, unless it demonstrates that it can make important differences in the lives of people? And when has there ever been research that was both important and non-controversial? When Stanley combines research with demonstration, in a project that he means to make as imitatable as possible, he is in fact making a commitment to a certain kind of knowledge, a certain way of understanding. It is an epistemological preference similar to the one that Beethoven makes when he researches ways of using diminished-seventh chords, and shows us his work in progress—for example, in the Fifth Symphony. Who *understands* music—the performer, the composer, or the musicologist? Stanley, it seems to me, is voting against the musicologist, who is not also a composer or a performer.

There are, of course, alternative methods for attempting to meet the needs of gifted students. Stanley, pointing out that both Terman and he have worked in LAS psychology departments, takes to task the educational psychology and mathematics education communities, for their neglect of gifted students. Mathematics educators, he says, "seem far more interested in curriculum development and textbooks for the average and somewhat-above-average student than for facilitation of the mathematically highly talented." Indeed one important direction for further research deals with the extent to which Stanley's work has implications for a broader slice of the population. At the symposium, during the discussion following Stanley's paper, an anonymous questioner remarked:

> I was educated in England. Over there it is customary for students to start algebra at say age 12, trigonometry at 14, and calculus at 16. This is a program designed for maybe the top 20-25% of the students or the academic top quarter. Is there any reason why American high schools could not teach that percentage of students while starting at the same age?

To this Stanley answered:

> We would advocate a similar procedure in a sizable junior high school located within a fairly high-talent area. Some schools do not have as much of a talent base coming to their school as others. Where there is a large seventh grade with considerable talent, we would recommend a seventh grade Algebra I class, an eighth grade Algebra II or plane geometry class, and in the ninth grade an Algebra II or geometry class. In other words, we recommend at least three years of precalculus mathematics for high-talent junior high schools. Of course, the best group academically would have to be picked.

Other investigators have tried to classify mathematics for the gifted in different ways. McKnight (1979) distinguishes four approaches: acceleration, enrichment, precocity, and sophistication. "Sophistication," the most novel, involves exploring topics more fully, more deeply, and more profoundly—for example, proving theorems about limits of sequences *before* using limits to define, say, the area of a circle. The answer πr^2 remains the same, but the idea of "area" becomes something entirely different. One curriculum for the gifted has been developed by Kaufman (Exner & Kaufman, 1978), another by McKnight et al. (Davis, Jockusch, & McKnight, 1978)—both are the kind of products of the mathematics education fraternity to which Stanley refers (and objects), but a complete consideration of mathematics for the gifted needs to consider a broad range of approaches.

Here, too, Stanley offers a suggestive innovation. All too often the worlds of psychology, anthropology, mathematics education, and operational school programs exist quite separately, hardly ever making contact. Reviews of educational research have often been limited to a narrow layer of activity—sometimes omitting operational school programs of great importance, even nationwide programs showing originality and having carefully-developed rationales, because they are not described in the few key journals the reviewer chose to consult. (One critic has said that R&D in education is mainly a storm on the surface of the ocean, hardly communicated to the classrooms of teachers and students on the ocean floor.) In contrast, Stanley has sought out operational school programs, which were represented in the 1975 symposium. Brief descriptions of several—in Florida, California, New Jersey, North Carolina, and elsewhere—are presented in a companion volume (Stanley, et al., 1978). The companion volume is disappointing and not very informative reading, perhaps due to the style of reporting. The idea of looking beyond the usual constraints, and in particular looking at classrooms "at the bottom of the ocean," is clearly an important one. We would do it without question in a political matter—what is preached from pulpits and argued in bars MUST be considered alongside what is published in *Foreign Affairs* and the *New York Review of Books*. In economics, we check current inventories, present plans of fund managers, and the current week on Wall Street in addition to the works of professional economists.

We would do it in matters of music or art—one cannot, even if one tries, exclude jazz, the Beatles, movies, and cartoon strips as important contributing factors on the modern scene. Yet all too often educational researchers *define* their subject in terms of what can be found in a few professional journals, ignoring the realities of schools and children except insofar as the schools and the children have been described in those (relatively few) journals. As a result, the complex nationwide phenomenon of "the new math" in the 1960s is not well documented, nor well understood; nor are we clear on the impact of open education; we know little about what goes on in various teacher centers; and we shall never be clear about the actual influence of John Dewey or Maria Montessori. Stanley's attempt to reach out and to include operational school programs for the gifted, alongside the usual scholarly discussions, is extremely well-advised; unfortunately the attempt is less than triumphant, but the reaching-out is still a good idea.

Indeed, the question of *what* percent of the student population we are discussing is wide open. William Johntz, in Berkeley, California, operates a program, Project SEED, in advanced mathematical topics, for a *majority* of low SES urban minority students; Philip Treisman, of the University of California, Berkeley, has a program at the high school–college level, again for urban minority students. Both programs are important, but neither is well-described in the usual professional journals. The same can be said for the very important program in mathematics for gifted students operated by Burt Kaufman and Andrea Rothbart, through Webster College, in St. Louis, Missouri. Finding out about programs of this type can be quite a job—but if we don't do it, then we do NOT know what is happening with gifted students. All we know is what has been alleged to be happening—or not happening.

One could also read *The Gifted* for its suggestive discussion of the evolution of measurement, with two strands intertwined, one focussing on "structure" and (nowadays) information-processing procedures, the other seeking to define and measure certain real-valued variables. Some readers would, I am sure, feel that the work of Minsky, Papert, Rumelhart, Ortony, and others has carried the information-processing strand beyond the point described in *The Gifted.* Perhaps future reports on SMPY will show a deeper study of those aspects of information-processing that distinguish gifted students from the less gifted. (There are, of course, serious questions now being raised about the "variable-measuring" strand; cf., e.g., Houts, 1977.)

Incidentally, concerning the education of the mathematically gifted, Stanley is not the most extreme extremist. Individual cases are known where highly gifted students have been encouraged to dispense with pre-college mathematics entirely (or nearly so), and to undertake instead remarkably advanced, and highly abstract, independent studies. For example, Pierre Deligne, born in Brussels, Belgium, in 1944, at the age of 14 was encouraged by M.J. Nijs, his high school math teacher, to study Bourbaki's *Elements of Mathematics*—one of the most abstract books in existence. Because of their emphasis on logic and abstraction, these books do not present the real numbers until *after* the presentation of general topology and abstract algebra. No motivation is given, other than logic and abstraction. This goes far beyond anything that Stanley has proposed for 14-year-olds.

How did it work? Alexander Grothendieck, one of the world's greatest living mathematicians, was described by Harvard colleagues as "more impressed (by Deligne) than we had ever seen him be by a young mathematician. At that time Deligne was 21 (years old) and Grothendieck immediately recognized him as his equal." (Mumford & Tate, 1978). At the age of 26 (in 1970), Deligne was appointed to a permanent full professorship at one of the major institutions in Europe. In 1973 he solved one of the hardest unsolved problems in all of mathematics—at that time Deligne was 29. He is described today as ". . .[combining] powerful technique, broad knowledge, daring imagination, and unfailing instinct for the key idea," and recently won the Fields Medal, which for mathematicians is the equivalent of the Nobel Prize.

Students like Deligne are rare. But for how many students do our schools fail to provide what they need? And to how large an extent is the failure attributable to a mechanistic operating philosophy, allied to a mechanistic psychology? The question is not facetious: in his review of 50 years of research on gifted children in Section I of *The Gifted*, Gowan argues that:

> Concern for the qualities of exceptional human beings arises out of an exceptional concern for the qualities of all human beings, and thus it is that we find humanistic psychologists of all types interested in the rights of man and woman. John Dewey was an early exponent of these individual rights, as was Carl R. Rogers a later one. Leta S. Hollingsworth, besides her eminence in the gifted-child movement was an early champion of women's rights. E. Paul Torrance has been diligent and effective in championing the rights of the uncommon student to be different, and in his concern for the creative disadvantaged student. This valuing of individual differences, this prizing of the idiosyncratic talents of the uncommon man, is the essence of guidance of gifted and creative persons. . .

. . .or, perhaps, of anyone.

The gifted child movement, in Gowan's view, is part of humanistic psychology, characterized by

> . . .a sense of the innate dignity, uniqueness, and worth of human individuality, which is seen as something transcending social groups, laws, restrictions, and generalities. The human being is not merely a reactive creature, but is an end in himself or herself.

> . . .psychology is defined by the humanists as the science of the mind or soul. . .and not the science of the rat.

The Gifted and The Creative has thus an underlying theme, not at all restricted to "gifted" students: a routine education industry, routinely processing batches of students, necessarily fails to deal with individuals, and all too often fails to deal with the subtle and profound things that students need to learn. This routine industry, in symbiotic relation with routine (i.e., "rat") psychology, is regrettably stable; only heroic interventions and major reconceptualizations can produce any significant improvement, and significant improvement is the only worthy goal of research. Judged in this light, how does educational R&D measure up?

After all, why NOT cure the common cold? Or even cancer? Or at least make the best effort of which we are capable.

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