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ABSTRACT

This paper was prepared as an introduction to the proceedings of a 1988 Conference on Academic Talent. The paper summarizes current National Science Foundation (NSF) policy in regard to the development of new science and mathematics curricula and describes the work of the Duke University Talent Identification Program in its efforts to reach and foster the talent of gifted youth. NSF concerns about existing curricula are discussed, and two strategies being used by NSF are identified: (1) upgrading curricula through widespread, incremental, short-term investments, and (2) implementing radical, long-term improvements by searching for the state of the art and "breakthroughs" in instructional strategies. Also included is an overview of the conference presentations, highlighting the salient points of each. Major themes of the presentations include: scientific curiosity and the integration of systems, theory and research in academic talent, educational and legislative policy in support of education for the gifted, and descriptions of programs to nurture the talent of children. (JDD)

CHAPTER I

INTRODUCTION

CONTEMPORARY ISSUES IN GIFTED EDUCATION

The Talent Identification Program/National Science Foundation (TIP/NSF) Conference on Academic Talent was a national, by-invitation-only, conference on issues associated with the research and successful delivery of educational services to academically talented students. Attendance at the conference was by invitation only and included those whose expertise would contribute to the conference goal of developing a research agenda for increasing the participation of academically gifted youth in the study of mathematics, science and engineering. Participants included speakers, who made formal presentations; discussants, who responded to the presentations with prepared remarks; and others whose professional responsibilities linked them to the conference goal of gifted youth undertaking study in mathematics, science and technology. A list of conference participants and their institutional affiliations reflects the range of educational and scientific institutions which were represented at the conference. Speakers and discussants were selected not only for their professional expertise, but also to represent the perspectives of four groups specifically defined by NSF: underrepresented minorities; practicing scientists; women; and teachers. The TIP/NSF Conference took place on March 28, 29 and 30, 1988, at the Sheraton University Center, Durham, NC.

The thematic content of the proceedings reflects the interest and concerns of the TIP executive staff as they discussed and developed, over the course of nearly two years, the proposal to the NSF. These discussions focused on issues of giftedness, recognizing that questions of program evaluation were linked in interesting and significant ways to those of identification, and that these were related to issues of national educational policy. Theoretical questions of the antecedents of talent and their relationship to identification procedures, programs, and policy formulation also arose as the purposes and anticipated outcomes of the conference began to be articulated.

This volume presents the proceedings of the conference--the keynote address, the student panel discussion, the invited dinner speech, and the nine major presentations and responses. The introductory chapter presents summaries of current NSF policy in regard to the development of new science and mathematics curricula and of the work of TIP in its efforts to reach and foster the talent of gifted youth. Also included in the introduction is an overview of the conference presentations, highlighting the salient points of each. We believe these proceedings represent some of the most well-informed, experienced and earnest thinking, to date, in the subjects of research, science and mathematics education, and the gifted child.

BACKGROUND TO THE CONFERENCE

NSF Policy: An Overview[1]

Since the early 1980's, the federal government has been taking an increased interest in secondary education policy. Various federal agencies, notably the National Science Foundation and the U.S. Department of Education, are working to reform education in mathematics and science, particularly at the K-12 level. In an attempt to create a greater number of science learners, the NSF has focused on the revitalization of a K-12 science and mathematics curricula, the science education of teaching professionals, and institutional infrastructure of K-12 science education.

In the opinion of the NSF officials, the current science curriculum of public schools emphasizes textbook knowledge over the development of intellectual skills. The elementary mathematics programs consist almost entirely of rote computation, whereas the advanced courses are assigned arbitrarily to certain grade levels and both mathematics and science courses are deficient in incorporating technology such as computers, or even calculators. The NSF's conception of the new science and mathematics education includes an interdisciplinary approach to the sciences, the integration of technology into the curricula, the investigation of the social and economic impacts of science and technology, encouraging in-depth and experiential learning, and a heterogenous instructional repertoire appropriate to a student population heterogenous on the basis of age and background.

The success of the restructuring of the curricula will be directly dependent upon the capability of the teachers. Currently, the majority of teachers are underqualified primarily because of the relatively low pay and the status of the teaching profession. By building a network of professionals, research scientists, engineers, and teachers, the community of practitioners concerned about science and mathematics education can be strengthened.

These two elements of instruction--quality of curricula and of teachers--are not the only influences on mathematics and science education. Within the organization of the local school system, policies, allocation of funds, teacher training programs, and administrative support which are inadequate or inappropriate also inhibit the ability of the NSF and wider professional circles to promote change. State level requirements on testing, graduation, and textbook use also limit the possibilities for changes in curricula. The responsibility of developing curricula should be removed from the control of publishers, media, scientific organizations, private consultants, test publishers, legislatures, and departments of education. The roles of these institutions should be redefined so that they work together to support different types of learning.

The NSF, working with other federal agencies, is in an excellent position to lead the reform of science education programs. It has a budget of $108 million for K-12 science education for fiscal 1988, and has gained a great deal of credibility

[1]Sources for this section are Knapp, Stearns, St. John and Zucker (1988) and *Higher Education and National Affairs* (2/15/88).

through the many successful projects it has supported in the past. In the 1960's and early 1970's, the NSF developed curricula which are still in use today. Recently, it has trained "leadership teachers", professionals who, together with curriculum specialists and others, become a valuable resource and support network for other teachers. The NSF's access to both scientific and educational communities facilitates networking among scientific educators, scholars, and practitioners.

The NSF is currently using two different, though not necessarily opposing, strategies:

1. To upgrade curricula through widespread, incremental, short-term investments.

2. To implement radical, long-term improvements by searching for the state of the art, and "breakthroughs" in instructional strategies.

Realistically, the outcome of the struggle for policy change is difficult to predict; it will be affected by several factors outside of the NSF's control, including federal policy and the societal reactions to attempted change. Congress may not maintain an interest in science education over several years; however, its work in this area in the 1960's and early 1970's demonstrates that maintaining this interest is possible. Right now, the preoccupation with maintaining economic competitiveness is likely to sustain the desire to improve mathematics and science education.

Erich Bloch, Director of the NSF, in a 1988 address to the American Physical Society and the American Association of Physics Teachers, pointed out that the decrease in the size of the college population of the United States, as well as the decrease in the rate of college students' choosing majors in the sciences and engineering, threatens the nation's technological preeminence. A possible remedy is for the federal government to allocate sufficient money for the improvement of science and technology programs. Bloch also stated that the NSF received a budget of $1.7 billion for the 1988 fiscal year--only a six percent increase over last year.

The societal factors at work are more difficult to identify than those due to federal policy. Certain educational strategies are so entrenched in American society that gaining support for dramatic change will be difficult. One encouraging note may be found in a recent survey of business, university, and state leaders, who identified research and education as the most important factors in the future of U.S. competitiveness. Education at the K-12 levels was cited as a particular concern.

The NSF has formulated policy to have a direct and enduring impact on the mathematics, science and technological curricula in the American public schools. Grant support from the NSF encompasses a range of activities implicated in the upgrading of curricula, including studies of cognition, especially as they result in improved classroom materials and better teacher preparation. The efforts of the Sputnik era, which resulted in quality science curricular units still in use today, serves as the model for current NSF policy.

The Talent Identification Program

One strategy in facilitating the educational development of academically talented adolescents is to involve them in existing regional talent searches. Currently, four searches, covering the 50 states, employ out-of-level measures of domain-specific achievement to evaluate the degree of students' academic giftedness, and subsequently, to direct extremely able students into programs appropriate to their level of ability.

The Duke University Talent Identification Program (TIP), the largest of the four regional talent searches, is a non-profit organization directed toward identifying academically able adolescents and assisting in their educational development (Sawyer, 1985a). The program also provides a range of student services, including counseling information, to assist students in better understanding their standardized test score national guide to programs outside the home school which can provide challenging academic experiences; and assistance in the placement of these gifted young people in colleges and universities. The program also includes a Research Division, which conducts investigations to increase the understanding of intellectual giftedness, the familial and contextual factors coincident with academic talent, and the academic and psychosocial needs of gifted adolescents.

The TIP Talent Search covers sixteen states including Alabama, Arkansas, Florida, Georgia, Iowa, Kansas, Kentucky, Louisiana, Mississippi, Missouri, North Carolina, Nebraska, Oklahoma, South Carolina, Tennessee, and Texas. Approximately 14,200 public and private schools with seventh grades lie within TIP's catchment area. Through the dissemination of informational materials to administrators, guidance counselors, and teachers, students are informed of the Search procedures. A student must score at or above the 97th percentile on the mathematics or verbal reasoning component or composite score of an age/grade-normed achievement test, such as the Iowa Test of Basic Skills (ITBS) or the California Achievement Test (CAT), to be eligible for the Search. Students applying to the Talent Search are to take the ACT or the SAT examinations normally used to assess the entry qualifications of high school seniors. The practice of out-of-level testing (Sawyer, 1985a) allows discrimination of a range of abilities within a "homogeneously" able sample. SAT scores within this group have been shown to be reliable predictors of ability and achievement in mathematics (Stanley, 1977-78) and of achievement in academically rigorous, accelerated programs (Sawyer, 1985b).

The results of the 1988 Talent Search demonstrated that seventh graders can do extremely well on the ACT or SAT. Of the Search participants who took one of the standardized tests, about one in four scored at least as high as the average college-bound high school senior on either the mathematics, verbal, or language use component of the tests. The large majority of these students take the examinations without the benefit of the four years of preparatory work and formal educational experience obtained by the usual test takers--high school juniors and seniors.

In recognition of their outstanding accomplishment, the higher scoring students are invited to ceremonies in their states and are presented with Certificates of Distinction. The top-scoring students are invited to a Grand Ceremony at Duke University where they receive awards of gifts and scholarships.

TIP also offers enriched or accelerated learning programs designed to challenge students to their fullest potential. The centerpiece of the educational programs is the Summer Residential Program which includes two three-week semesters and is held on the Duke University campus. To qualify for the Summer Residential Program students must score at or above the seventy-third percentile of the college-bound high-school seniors in the mathematics or verbal component of either of the designated standardized tests. Other services provided by TIP include additional on-campus programs, such as the Precollege and Commuter Programs, and outreach to the participating schools, including the creation and distribution of manuals for Advanced Placement courses for many different subjects.

THE CONFERENCE: AN OVERVIEW OF MAJOR THEMES

The conference hosted two special presentations, the keynote address and a student panel discussion. The keynote addressed the problem of maintaining the vitality of the individual, in physical well-being and intellect, in the context of institutions which are oftentimes governed by policies unresponsive to individual needs. The student panel, consisting of four young people studying mathematics or science, critiqued the educational services available to them from the perspective of the academically gifted student.

The keynote and responses introduced themes which were echoed throughout the conference in various forms and from many different perspectives. In general, these recurring themes were:

1. Intellectual curiosity is an essential element of high quality scientific and mathematical thinking.

2. The inadequate condition of science and mathematics education in America is reminiscent of that of the "Sputnik era." This comparison illustrates that high quality education requires vigilance and that integrating federal and local efforts can have a measurable impact on improving the quality of education.

3. Efforts to upgrade education for both talented and competent students are warranted, given the inadequate science and mathematics education currently offered in the representative American school.

4. Resistance to intervention in local education, while protecting the diversity of the system, frequently inhibits efforts to improve education.

Other speakers introduced major themes which, together with the keynote concerns, formed the core of issues upon which the conference focused. These latter are:

5. The decreasing size of the 18-21 year-old cohort aggravates the need for increased numbers of graduates in the fields of science, mathematics, and technology to meet the need of the nation anticipated by the twenty-first century.

6. The cultivation of the talents of underrepresented groups, i.e., minorities and females, is a promising strategy for meeting the nation's technological needs.

7. Restricting the study of predictors of achievement solely to psychometric measures leads to too-narrow a picture of talent. Use of these measures of ability should be tempered with the cautions that:

    a. In general, psychometric measure underpredict achievement for females and minorities.

    b. Research in the noncognitive factors rooted both in the personality and the environment will broaden our understanding of the underpinnings of career and life achievement.

Keynote: Scientific Curiosity and the Integration of Systems

Dr. Alvin Trivelpiece, the keynote speaker, is the Executive Officer of the American Association for the Advancement of Science (AAAS). In his address, he emphasized the need to protect and nurture curiosity as the quality most crucial to the flourishing of scientific talent, and the problem of integrating education from preschool to college. Subsequent educational efforts must build on those preceding, and the course of an individual's education should be informed by the need to foster and protect the student's intellectual growth.

Keeping curiosity alive is central to developing the habits of inquiry which underpin scientific interest and ability. The mastery of the theoretical principles of a discipline should not supplant the development of natural curiosity. The importance of curiosity compared to mastery of theory should caution educators to pay particular attention to the danger of diminishing children's interest and enthusiasm for learning.

Programs must become the arena where theoretical underpinnings and policy provisions come together. Programs are not simply the structured environment of a single classroom, Trivelpiece observed, but a sequence of educational supports which are vertically integrated, that build on the productive outcomes of the preceding step, and move toward meeting the academic requirements of higher education and the manpower requirements of the national workforce.

The responses to the keynote speech focused on similar themes: nurturance of talent and the integration of social policies that provide adequate support and protection for the development of the child. The questions of why programs from the "Sputnik era" did not survive, and why mathematics and science education are again neglected, are matters needing national attention. The source of these problems is rooted in society's conflicting values, particularly with regard to the intrusion of government into the family. These conflicting values are also partly responsible for the lack of vertical integration of educational policy in the United States.

An indication of the obvious need to attend to specific problems in the educational system can be found in the similarities of the presentations by the keynote speaker and the four students participating in the panel discussion. Trivelpiece presented the broad statement of the problems; the students provided specific examples to justify his case.

Trivelpiece spoke of the importance of maintaining curiosity in order to stimulate students' continued interest in mathematics and science careers. The students, in their criticisms of the bland academic diet they received in the regular classroom, reinforced this claim insisting that the environment of the regular classroom often deterred rather than facilitated learning in their areas of interests. The students suggested that the presence of special programs which allowed them to learn at an appropriate pace was not only a relief, but a necessary component in their progress toward careers in mathematics, science, or engineering.

Creating a unified effort among the various levels of education was a major point in the keynote address. The student panel supported this concept by noting how disjointed their own education had been, being provided with appropriate programming only at special moments in the course of their education, and at other times being left to fend for themselves in the regular classroom atmosphere. One of the students mentioned that as a result of changing criteria for identification from grade to grade the very presence of talent could be made to seem like a transient component of her personality.

Finally, the students' presentation underscored the concern for broadening the scope of gifted education to include more members of underpresented groups. In fact, the very composition of the panel served as a reminder of the diverse nature of the population of gifted students. Two white females, a white male and a black male were members of the panel. Each person represented a unique set of needs and a different approach to programming. The diverse nature of the group was also made clear in the presentations when a female student brought forth evidence of gender discrimination, and when the black male spoke of his special motivation to achieve in order to be a role model to other students.

Theory and Research in Academic Talent

The theory of intelligence and its academic, psychological, and social correlates has a special bearing on the study of high cognitive ability. Talent is a valuable human resource which potentially yields very high return rates on an investment. A large proportion of individuals who enter the disciplines targeted for critical shortfalls by the year 2000 will come from the cohorts of talented students identified by TIP and similar programs for talented students.

One question dominated the discussion of theory: What are the special characteristics of the child, either cognitive or affective, which cause or enable him or her to learn at an accelerated pace? The theory that is developed in response to these questions, in turn, bears on the delivery of services and what educational and social supports respond best to the child's needs. A second question arising in the discussion of theory reiterated a recurring theme: How do the results of research on the gifted generalize to the population of competent learners? The discussion focusing on the theoretical aspects of academic giftedness addressed three aspects of cognitive theory:

1. Models that account for achieved and precursor abilities and how these are measured or predicted.

2. Models that account for changes in the measure of cognitive ability, including methods of alternative representations.

3. Models that include noncognitive factors in accounting for cognitive development.

The second presentation on this topic focused on leadership theory and the need for the academically talented to participate in leadership. The third presentation discussed the needs and means for developing a national database to study scientific, mathematical and technological talent.

Cognitive Theory and Scientific Talent. The first presentation, by Perkins and Simmons, explored the underpinnings of contemporary theories of cognition in an attempt to account for and predict scientific and mathematical ability. Achieved ability, according to these authors, is the combination of structures and processes that comprise the individual's comprehension and problem solving capacity in a discipline. Precursor abilities must be at some "remove" from the domain ability being tested, otherwise the distinction between achieved and precursor abilities is collapsed.

The discussion of the cognitive roots of abilities was advanced with a dialectical model, contrasting what is with what lies beyond cognitive attributes. Expert behavior, an essential component of achieved ability, is characterized by three attributes:

1. A "quick, recognition-like orientation to the 'deep structure' of problems".

2. A superior ability to remember typical but not atypical situations.

3. The ability to reason forward, using context-specific models that permit access to relevant domain-specific principles.

The limits of expertise are discovered when an atypical situation calls for innovative use of a discipline's principles. Beyond expertise, thinking that can broach atypical situations must use general and specific knowledge flexibly to solve a problem. Flexible thinking, then, exhibits the quality of understanding that moves beyond simple expertise.

Problem solving, emphasized in mathematics and science, is an attribute of achieved ability distinct from expert behavior and understanding. Polya (1957) encouraged the development of a heuristic of problem solving. This technique is limited, however, by students failing to apply the heuristic while attempting to solve the problem. The notion of problem management, in which students gain a self-conscious, "executive" control (Schoenfeld, 1985) of problem solving skills, was introduced as a means of enhancing problem solving behavior. Beyond problem management is problem finding, perhaps the most creative arena of performance for expert mathematicians and scientists.

The verification of achieved abilities is a relatively reliable phenomenon given the clearly operationalized definitions that exist for expert behaviors in various disciplines. But the question remains as to what kinds of abilities, if any, predict or explain subsequent outstanding achievement.

An alternative model to intelligence theories is the developmental model, the most famous being that of Piaget, who posited a four-stage theory. Upon reviewing the predictive power of precursor versus achieved abilities theories, however, we find that achieved abilities and even personality factors are much better predictors. Theories of precursor abilities are important because they force the researcher to look with a broader perspective at the individual and environmental traits which occur with giftedness.

Perhaps the most important feature about the existing theoretical structures is that they help to identify what questions would be most useful to ask about how cognitive development occurs among the academically talented. The Perkins and Simmons paper provided a useful overview of this problem for the domains of science and mathematics. It acknowledged that general problem solving may be at the heart of good performance and suggested that the ability to find and formulate problems is important, as well. The first response to this presentation introduced an additional concept, "alternative representations," which helped to expand the framework for studying academic talent and described a new way to study problem finding in that context.

The Alternative Representations Approach. Two simple notions introduce the alternative representations approach. First, all ideas can be represented in many different ways--such as sentences, lists, outlines, tree diagrams, matrices, graphs, and pictures. This is true no matter whether the content involves academic or everyday information, is simple or complex, brief or extensive in length. Second, the way a given idea is presented has clear cognitive consequences. That is, representations affect cognitive processes such as perception, memory, concept information, comprehension, and problem solving. To illustrate these notions, examples from specific science domains (e.g., chemistry) as well as some which cut across domains (e.g., data analysis) were used. The discussion of chemistry molecules illustrates the concept and some of the implications of alternative representations.

Students have difficulty learning organic chemistry for a variety of reasons, including the sheer amount and complexity of the information involved. However, the notation systems chemists use to represent three-dimensional molecules in two-dimensional form (in textbooks, on blackboards) may be part of the problem (Day, 1984).

Students who participated in experiments in alternative representations were given a notational form and asked to determine whether they showed the same or different molecules, independent of notational variations. Their performance depended on what notational system was used; one system was easy to use and led to superior performance, while another was difficult and led to inferior performance.

Other experiments in data analysis investigated how well students can think scientifically. To study this question, students were given a small set of data from a simple experiment and asked to extract some basic results. Providing the same data in alternative representations affects their ability to solve simple problems accurately. More interestingly, though, such representations also affect their ability to find and solve more subtle problems embedded in the data. Subjects in the favorable representation groups, then, look as if they possess greater "scientific talent."

The alternative representations approach holds some interesting implications for understanding "talent" and for considering educational practice for both talented and competent students. The experiments by Day and others show that good students can be made to *look* more or less talented in a given domain simply by giving them specific representations of key information. Perhaps what sets talented students apart from the rest is that they already know how to represent concepts in many ways and to select representations that work well for various tasks. Perhaps the ability to use alternative representations unlocks "talent;" if so, then instruction might well include explicit alternative representations of important concepts.

Contemporary Cognitive Theory. Dr. Edward Zigler's discussion of theory shifted the perpective on theory from close scrutiny of models of cognition to a broad-scoped discussion of cognitive theory in the societal context. The discussion opened with the observation that contemporary cognitive theory has three paradigms to work with:

1. Psychometric
2. Cognitive/developmental
3. Information processing

Although each of these models contributes to our understanding of intelligence, the psychometric model has not been bettered for its predictive power. Over the next 30 years, however, it may be possible to overcome inherent bias in testing simply by tapping an individual's physiology. This path of theoretical development seems more likely to be productive than that of, for example, whether *g* or *s* is right, as any complete model will have to incorporate both concepts. The limitations of both is that they are tied to the psychometric paradigm, which unfortunately, is thought of as distinct from the cognitive/developmental approach.

In regard to information processing, it seems too early to determine whether the triarchic theory of intelligence will add to predictive ability of theory. Among the three models, the psychometric, cognitive/developmental and information processing, the model preferred for its contribution to understanding intelligence is the cognitive/developmental model. Developmental models help illuminate our understanding of giftedness by putting intelligence in the context of *rate* of development. The speed at which an individual acquires knowledge and understanding is a critical element in any theory attempting to identify precursor abilities. A second important element has to do with individual differences. that is, the final stage at which a person's cognitive development stops.

Another issue in development is that of creativity versus intelligence. Most theorists agree that intelligence is a necessary but not sufficient component of creativity. These models bring attention to a persistent dilemma in the discussion of intelligence, and in particular in measuring intelligence with intelligence quotients. Attempts to define creativity always sound like the best way to define intelligence, suggesting that measures of creativity ought to be included in intelligence tests.

When undertaking the explanation of this phenomenon, the issue of motivation must not be neglected. Although much has been said about environment and the influence of parents in producing genius, these factors are not generally those that produce most geniuses and creative people. The extrinsic motivation provided by the environment is markedly different from intrinsic or affectance motivation. The latter, working for the sheer joy of using the intellect, is much more likely to characterize people of extraordinary ability and achievement.

Zigler's final point addressed the question of what happens to the curiosity and natural inquisitiveness that is characteristic of the young child. Recognizing that play is essential to preserving and developing curiosity and self-discovery is the first step. Effective school leadership using the resources, from the federal government to local school systems, could also improve education.

Theory of Leadership and the Gifted

While the discussion of cognitive theory explored on an individual scale the environmental and cognitive events associated with the occurrence of a high level of mental ability, the discussion of leadership theory explored the implications of talent, its responsibilities and the societal vehicles which facilitate its expression. The gifted play an important role in improving the quality of society; nurturing talent is important to ensure that society's human resource needs are met. Conversely, individuals with scientific ability must be prepared to assume roles of leadership to improve the quality of the society.

In regard to developing talent in science, technology and mathematics, a liberal education that imbues knowledge of and loyalty to societal structures and institutions is essential. Educational programs dedicated to these goals must develop in their participants skills of rigorous, analytical thinking. The cultivation of these qualities in talented individuals will result, ultimately, in good governance and human relations.

The respondents to the initial presentation concurred with the central thesis that those educated in scientific and technological careers are needed in the broader leadership roles of the society. This argument finds strong support among contemporary students of the problem of developing sufficient scientific talent for the future. It is important to note that scientists and engineers educated in America receive broader and better balanced educations than students of history or philosophy. The latter tend to be oblivious to the importance of scientific knowledge and to the excitement of current scientific developments and their potential to change our lives. Scientists, on the other hand, are more aware of the substance of the change that is occurring in our society.

Other important points made by the participants in this session were:

1. Scientists and engineers appear to be filling a disproportionately large share of leadership roles;

2. The size of the scientific/technological talent pool is dwindling and may not be sufficient to meet the nation's human resource requirements;

3. One means of solving this problem is to begin cultivating the scientific talent among females and minorities;

4. The criteria currently used to identify future professionals, i.e., largely standardized test scores, are too circumscribed.

The problem of finding enough scientific talent is compounded by the fact that scientific and engineering majors are recruited from among all high academic achievers; thus, the competition with other specializations intensifies. Adding leadership responsibilities to the possible life work of high academic achievers further increases the competition for available talent. One important approach to solving this problem is to begin cultivating the scientific talent among females and minorities. Another important strategy is to rethink the criteria that are used to identify future professionals.

Theoretical Basis of a National Database

Sawyer, in the proposal to establish a national database, spoke from the perspective of having data and needing appropriately powerful theory to interpret and make use of them. Consequently, this presentation identified many practical benefits of having a coherent theoretical basis for research.

The establishment of a national database would enhance the development of methodical and self-conscious research, helping to minimize redundancy, conserving scarce resources, and facilitating individual research undertakings. At the same time, theoretical issues identified as essential to effective utilization of a national database were strikingly similar to Zigler's discussion of cognitive theory. Specific topics which would promote a clearer understanding of mathematical and scientific talent within a development context include:

1. Investigation of developmental pace or rate.

2. The relationship among intellect, personality and socialization.

3. Factors bearing on educational and vocational choice and success.

4. Stress, resilience and coping behaviors.

5. The effects of educational interventions.

The discussion of the national database focused on the study of talent, how its manifestations change over the lifespan, and how the biological and psychosocial processes are associated with stability. Insight into these initial problems may help to answer questions of whether early identification is warranted, not only for the benefit of the society, but for the well-being of the child. In evaluating the use of interventions, questions of when and how to intervene must be finely-grained enough to look at whether there are relative effects on the component parts of talent, and with an eye to identifying possible risks. The considerable research on the correlates of resilience and stress, signaling the importance of self-efficacy and family functioning, must be extended to include gifted individuals.

In the subsequent discussion, it was observed that the concept of a national database would enable researchers to examine the nature of talent and the ways in which talent may be encouraged and developed in ways that would obviate the reactive posture of the educational community. The development of such a database, however, presents serious logistical difficulties, but there are a number of suggestions as to how data collection in support of a national database could be developed. It would be possible, for example, for local schools, using a prescribed format, to submit data to a national information center on a floppy disc. These data could be used to help colleges, industry, and private research foundations to identify pupils who could benefit from specific educational and work and research activities prior to finishing high school.

This discussion emphasized one of the themes voiced repeatedly by participants that all talents are valuable, and that all people, in one way or another, are talented. Our society has the resources to provide for the special needs of one group, while also providing opportunities for the larger group to develop their own skills to the fullest extent.

Summary

Discussion of theory ranged from consideration of practical problems to theoretical models for understanding and resolving these problems. A major concern was the increasing scarcity of talent not only for scientific and technological endeavors but also for societal leadership. The development of a cognitive model that would accurately predict success in these capacities would aid in the identification and developmental of talent. Unfortunately, the most clearly formulated theories tend to isolate cognitive from noncognitive factors relevant to life achievement. The limitations of psychometric testing to predict career success were noted, pointing to the need for a broader perspective that includes factors of motivation, environmental context, developmental events, and rate of change. Educators and legislators must be aware that, while test scores can be a convenient and valuable source of information, they are not the only source of information.

Educational and Legislative Policy in Support of Education for the Gifted

Considerations of policy focused primarily on the ways in which federal and state agencies may intervene in educational practice to meet societal needs for increased levels of expertise. Interventions were most often conceived in the form of financial support, with policy establishing parameters for the use of allocated funds. Generally, policy was defined at the national level as the legislative constraints placed on the disposition of funds and, additionally, at the state and local levels, as the criteria which circumscribe programs or agencies in order to implement certain priorities. Participants in this session tended to support policy that generated and funded a variety of programs. The degree to which monies are allocated for well-defined, coherent policies formed a strong thread of argument throughout the conference, with opinion favoring stronger, clearer policies in support of gifted and talented education. Policy priorities identified as means to satisfy scientific and technological human resource needs were:

1. Improved science and mathematics training and better remuneration for teachers;

2. Upgraded science and mathematics curricula, including instructional use of computers and telecommunications equipment;

3. A shift in recruitment strategies to emphasize minorities and females.

4. Better use of research and of scholar/practitioner networks in generating and disseminating research findings.

A major policy presentation was made by Ernst Blanke, Deputy Minister of Education the Federal Republic of Germany. Perhaps the most interesting aspect of Blanke's speech was the simlarity of educational concerns between the United States and Germany and, in particular, in the increasing needs for technological expertise and the strategies used to identify talent and foster its development.

Policy of the Federal Republic of Germany

Blanke spoke about the present needs of the Federal Republic of Germany for technological expertise and the strategies to nurture the development of academic talent in mathematics, science and technology. Although the labor market for mathematicians, scientists and engineers in the nation is relatively stable, major changes are expected that will require increased levels of technical knowledge. The Federal Republic of Germany enjoys a very high standard of living. To maintain this quality of life, "a constant stream of quality products, production techniques and services must be offered". Thus, development of academic talent, particularly in the fields of mathematics, science and technology, has been recognized since the early eighties as "a major task for education." Some of the means of promoting awareness of the need for expertise in certain fields are federal competitions, working groups at the school level, focusing on special subject areas, summer courses patterned on the accelerative models used in the United States, and in-service training for teachers. In the higher education sector, structures are emphasized which promote the admission of highly talented students to special study programs and their direct involvement in research activities.

Increased effort research in the Federal Republic of Germany is needed in three areas:

1. Finding a means of identifying talent and promoting its development through the training of third party providers.

2. Identifying the causes of the low participation of women in mathematics, science and engineering.

3. Exploring the use of leisure time to provide opportunities for the development of talent.

Policy at the National and Local Levels

The report on the current status of legislation relevant to the education of the gifted and talented observed that, in regard to federal policy on scientific and technological education of the academically talented, two points should be kept in mind:

1. Although much attention is given to both education of academically gifted and talented and in mathematics, science and technology, these topics are rarely addressed in the same breath.

2. Only about 8.7 percent of the total expenditures for elementary, secondary, and postsecondary education is contributed by the federal government. The total federal expenditure for elementary and secondary education is only 6.1 percent. Despite these relatively limited expenditures, federal legislation does have a significant impact on education at the local level.

Currently federal educational legislation has two major themes, equity and access, with emphasis being given to the role of education in maintaining economic competitiveness and national security.

Gifted and Talented. In legislation for the gifted and talented, the consistent theme is one of the need educate the best students to maintain the nation's competitive position as a world leader.

The Jacob K. Javits Gifted and Talented Children and Youth Education Act is the primary piece of legislation for the gifted to be introduced in the 100th Congress. The legislation provides, among other things, for the authorization of $25 million for fiscal 1988, for grants or contracts to State and local educational agencies, institutions of higher education; for establishing a National Center for Research and Development in the Education of Gifted and Talented Children and Youth; for at least half of the grants to be awarded to projects that service the economically disadvantaged.

Other legislation which would support the education of gifted children are the Chapter 2 Block Grants and several of legislation for special groups.

Mathematics, Science and Technology Education. Funding for improvement in mathematics and science in the omnibus education bill would be based on modification of the current EESA Title II.

A representative from the NSF expanded on discussion of policy embodied in legislation with a description of that agency's grant-making policy. The work of the NSF is directed toward upgrading the American educational system in stable and enduring ways. The issues of research and knowledge may not be treated as objectively as is necessary to clarify whether more knowledge is needed to achieve this goal of cultivating scientific talent. It is possible that more is already known than is being put into practice, and the most formidable obstacle to the goal of developing talent may not be lack of knowledge but how to apply knowledge, using existing structures.

Congress is presently appropriating monies for the development of scientific curricula because representatives are persuaded that the country is seriously threatened by external competition and the poor quality of education which will shape our manpower resources for the next generation. Congressional representatives want research and knowledge to be used to improve the quality of education, but intervening in the educational system poses real problems. The system is large, deteriorating and in need of repair; the strength of the American public school system is its diversity, a quality jealously guarded at the local level.

The educational system, in terms of the development of scientific talent, may be thought of as a net which captures at grade one 100 percent of all available talent, but by the end of four years of high school, only 75 percent of the initial population finishes high school, 25 percent of the population has already dropped out.

The future society will need a full technological infrastructure, not just a cadre of scientific elites, including:

1. An educated populace that can read the newspaper.

2. A managerial decision-making cadre conversant in science and engineering.

3. People appropriately educated to support the technological infrastructure.

4. On the peak of this hierarchy a good supply of gifted and talented people are needed for leadership.

The NSF plans to meet these needs by building a consistent, coherent base of science and mathematics education that spans kindergarten through grade twelve. The goal of the science curriculum is to give students an overview of science, regardless of their eventual role in life. The curriculum will be designed to prepare all students for college level science as well as to provide some level of scientific literacy for the 50 percent of the population who are going to conclude their science education at high school.

A third discussion of federal policy focused on funding policies from the bottom up perspective, taking Minnesota as the point of reference. This perspective helped illuminate the political dispositions and structural needs of educators in the state and local school systems.

A point made previously was reiterated here: that federal intrusion into local education is not welcome. Educators at the local level direct their loyalties to the voter and are less responsive to distant federal proclamations. State and local officials of a sample state school system uniformly support the new system for administering Chapter 2 block grants, for example, because they feel that it requires less paperwork and affords greater freedom to use funds creatively. The net effect of this assessment is that less intrusion is equated with better education. Unfortunately, the changes in the Chapter 2 block grants are likely to increase the difficulty of obtaining funds for mathematics or gifted and talented programs.

In general, federal funding generates recurring problems at the local level. To begin with, federal monies are viewed from the local perspective as being small in comparison to local monies; the timing of federal funding creates of problems, as well. The political vying that attends Congressional appropriations makes funds available on short notice and for only short time periods. More clearly marked priorities and a full year planning/funding cycle would assist school districts in making better use of funds. Other weaknesses in science and mathematics education are poor textbooks and underprepared teachers.

In regard to highly gifted students, it appears that public schools can serve only in densely populated areas. Multidistrict pullout programs offer alternative models for gathering enough students to form classes of adequate size and have the advantage of being less expensive than residential programs. Despite these limitations Americans appear, overall to have developed a very humane educational environment. Care should be taken not to destroy this quality while implementing more academically challenging programs.

Scholar/Practitioner Networks

The discussion of scholar/practitioner networks focused on the structural and evaluative qualities required for successful networks and emphasized the problems and benefits that arise when attempts are made to apply results of research to the practice of education. The major topic was the efforts to establish the procedures and structures promoting collaboration in research and policymaking for the Government-University-Industry Research Roundtable (GUIRR). The GUIRR, in recent policy formulation, signaled the development and retention of science and engineering talent as the most critical issue in the practice of science. The results of a Roundtable symposium show that, generally, students are choosing utilitarian degrees and demonstrating declining interest in undergraduate and graduate study of the physical sciences. Even the most highly qualified students are included in these trends, but an additional and worrisome concern is connected to projected decline in the number of twenty-two year olds. The size of this cohort is anticipated to decline by more than 25 percent by the year 2000.

An unsettling characteristic of discussions of the scientific manpower needs of the nation is that the data are not conclusive. The flow of scientific talent is critical to scientific and engineering advances. It is therefore crucial to understand the factors that influence students to elect careers in science and research. The development of high quality scholar/practitioner networks is an important means of concurrently evaluating the status of this potential crisis and of testing possible solutions. The list of principles for establishing functioning networks is based on observing a wide range of programs, a large part of whose work includes some kind of networking. A successful network must:

1. Involve the best scholars and practitioners to evidence the legitimacy of the activity.

2. Involve senior officials who have the authority make policy.

3. Address issues which are intellectually challenging to participants and in the interest of the institutions they represent. Uneven distribution of organizational self-interest results in exploitation of one group by another; even distribution of self-interest results in collaboration to solve a problem of high priority.

4. Establish short and long term objectives.

5. Have sufficient financial and staff support.

6. Be flexible in its ability to respond to the demands and opportunities of various participants.

7. Focus attention on the core participants and the problems they have chosen to address.

8. Be sponsored by organizations which are neutral with regard to network goals, problems and solutions; the sponsoring agency or agencies must be credible to the network members.

Networks may be formed at the local, state or national level. Examples of networks concerned with the issues of the conference, i.e., educating the academically talented in science, mathematics and engineering, include the Mathematical Sciences Education Board (MSEB), and the Ford Foundation Urban Mathematics Collaboratives.

By observing the criteria outlined above, it may be possible to promote the development of a network which can communicate the respective needs and contributions of scholars and practitioners whose expertise bears on the issue of improving scientific, mathematical, and technological education for our nation's most gifted youth.

The response to this formal presentation shifted the focus to a more fundamental aspect of networking, that networks could be established to develop talent in the targeted fields. The discussion of the required aspects of a network and the examples of successful networks give rise to the question of what kinds of structures promote the "culture of science." This discussion, especially in its emphasis on curiosity, echoed the concerns of the keynote address. The communication of the culture of science, including mathematics, is essential to developing talent in these areas. The nature of this culture is a belief structure that places the highest value on curiosity. Thus, the posing of "the good question" is of a higher priority than having all the answers. Other highly valued qualities contribute to the posing of the good question. First among these is the interplay between imagination and reality. Fantasy and imagination are the sources of scientific descriptions, theories and other conceptual insights, when they are linked to logical reasoning and empirical testing. The quality of veracity is another important value in the scientific culture. Being able to see data for what they are, and being able to rely on the validity of another's data crucial to the practice of science. A value arising as a consequence of these tenets is the legitimacy of error. The method of trial and error is central to testing descriptions and theories, and error is an important source of knowledge, as the practice of science provides that we learn from our mistakes. The last attribute of the culture of science, which is supported by the other values, is that of replacing beliefs with persuasion rather than coercion.

This culture, taken as a whole, supports one of the most important of human enterprises, that of inventing new axioms and creating knowledge. The enterprise of enlisting students' interest and excitement in the study of mathematics and science affords the opportunity to *make* mathematics and science, rather than just to acquire facts. This is especially important with academically talented youth who are likely to be the mathematicians and scientists of the future.

One practical way in which the NSF is helping to promote the development of talent, as well as the development of scholar/practitioner networks, is the Young Scholars Program. Key aspects of the activities, again, recall the themes of the keynote address:

1. The exercise of natural curiosity is one of the best ways to learn science.

2. Students should be exposed to environments that promote interest and experience in problem solving and research methods.

3. Activities should achieve a balance among lecture, laboratory, field and research, should be interdisciplinary, and should promote interaction between experts and students.

The current level of funding at a little over $3.5 million is likely to double to $7 million with the approval of Congress. This program provides the opportunity for networking between practitioners at university research laboratories, field stations, and industrial and government laboratories and our best students.

The second respondant to the presentation on networking spoke to the question of improving science education by observing that because of what highly talented people potentially can do to improve the human condition, the nourishment and preservation of their talent is a matter of great importance. Although people with other specialties may make equal contributions, the support of those with skills in science and mathematics is particularly urgent in this age of high technology. One measure of success in the achievement of this goal is the number of people who receive the doctoral degree in some branch of science and mathematics.

Over the last twenty years, in American universities there has been a general increase in the number of individuals who receive their Ph.D.'s in science. For a moment one might conclude that we are doing very well. Details of the data reveal, however, that there are reasons to draw conclusions with caution. The number of Ph.D.'s in the physical sciences has declined while Ph.D.'s in engineering have increased. Similarly, the number of Ph.D.'s in research and academic psychology has decreased while those in health services have increased by about a factor of three.

The reason for these changes is primarily economic. Students are entering fields that are practical, well paid and available, resulting in an insufficiency of qualified students in some crucial areas. Another factor keeping students out of science and mathematics majors is inadequate preparation. Many college students find out when they take their first course in science that they lack the skills that are taken as assumed prerequisites.

Structures called "scholar/practitioner networks" have been created to deal with the shortcomings of science education in America. These networks, comprised of people committed to science education, able to work together, and possessed of appropriate expertise, undertake a wide range of activities and support a wide variety of projects aimed at improving the situation of science in our country. They encourage research, support symposia and workshops, offer fellowships and internships, establish policy and priorities, and facilitate communication through meetings and publications.

As short-term goals, these accomplishments are to be applauded. It is unclear, however, whether there is any enduring impact on the problem at its source, the reluctance of society to provide adequate support for scientific education and research.

Summary

Among the themes touched upon in the discussion of policy perhaps the most striking is the similarity in the profile of problems, possible solutions and research issues between the Federal Republic of Germany and the United States. A dearth of scientific and technological talent is anticipated for both nations by the year 2000; the related issue of maintaining an existing high standard of living lends impetus to the search for solutions. Two strategies endorsed by representatives of both countries were the nurturing of talent through special educational program and further research on the reasons for low participation of females in the fields of mathematics and science. Contributors to the discussion of policy in the U.S. spoke in detail to the problems and possible solutions to the nurturance of talent. Top down interventions from federal to state or local levels tend to come in the form of funding from legislative and federal agency sources.

The needs of traditionally underserved groups--females, minorities, and economically disadvantaged groups--are receiving special attention in the program priorities of the NSF and in current legislation. Emphasis at the NSF on the recruitment of females and minorities is based on the belief that these groups will contribute the largest proportion of talent in the next decade. Legislation for other minorities, such as the handicapped, also is inspired by the desire to assist neglected groups and individuals in the fulfillment of their potential.

The problem of improving the quality of science and mathematics curricula includes not only changing the curricula, but retraining teachers, reformulating policies that are more realistic about demands made on teachers, and involving scholars and practitioners in networks that facilitate communication about discipline-related problems and research developments. Involving teacher/practitioners in dialogue with other experts keeps the lines of communication open between scientist/scholars and the classroom, and stimulates a more challenging atmosphere for both teacher and student. While there was some consensus among the speakers that simply increasing funds for the gifted education would not automatically increase the quality of graduates in mathematics and science, there was also recognition that the quality of students entering these fields was related to the level of remuneration available to graduates in the targeted disciplines. The discussion of policy reinforced the perspective that efforts integrating systems are necessary for the delivery of a satisfactory level of educational services for gifted children.

Programs to Nurture the Talent of Children

The variety of programs described throughout the conference reflected the position held by most participants, that there is no single program format which will meet the needs of all gifted students. Even though programs may share similar goals, the diversity among the population of gifted students requires the development and support of a wide range of programs.

Questions of how to provide programming for gifted students were approached from three different perspectives. The first perspective described how meaningful, differentiated programs for gifted students are created, the second, ways in which curricula could be designed to meet the special needs of gifted students. The third perspective described programs designed to increase the representation of minority students among the gifted.

Differentiated Programming for Gifted Students

The presentation by William Durden, Director of the Center for the Advancement of Academically Talented Youth (CTY), emphasized two points, the importance of a central belief system to program development and the use of four basic components to create a program for gifted students. Stephanie Marshall, Director of the Illinois Mathematics and Science Academy (IMSA), discussed these two points, as well as the processes of faculty selection and of securing public support.

The talent search concept originated at The Johns Hopkins University with the Study of Mathematically Precocious Youth (SMPY). Founded in 1968, the steady growth of the program led to its division into two parts, the SMPY program for highly mathematically gifted students and CTY, which caters to gifted seventh graders with either high quantitiative or verbal ability.

The policy statements established for CTY are based on a belief system advocating supplemental programming for gifted and talented students. The belief system represents a philosophical attitude about the nature of talent and provides an operational definition of the kind of talent that the program identifies and nurtures. The three major policies are:

1. *General policy*: The function of the CTY program is to assist in the development of maturing talent;

2. *Identification policy:* The operational definition of the population includes academically talented students with above-average verbal and mathematical aptitude;

3. *Programming policy:* Enrichment and acceleration must be combined in academic programs; assessing prior knowledge and relative improvement is critical to providing programming at an appropriate level.

CTY provides academically talented students with individualized instruction at an appropriate pace, usually in a summer program that allows students to focus intensely on one subject. IMSA also advocates individualized instruction and pacing but emphasizes discovery as the catalyst of learning. The IMSA program is based on a laboratory-oriented, experiential model of teaching and learning, with an emphasis on interdisciplinary and integrative studies.

In combination, the programs described by Durden and Marshall provided a framework for many programs for talented student; but both acknowledged the importance of the same components as the cornerstone of their programs:

1. A rigorous academic program.

2. Affiliation with a university.

3. Curricula based on a combination of acceleration and enrichment.

4. A residential component.

5. Highly qualified and motivated staff.

6. A research component.

This broad framework provides flexibility to match curriculum and program goals to the group of students the respective programs seek to serve.

Curriculum for Talented Students

A sound program design is only the beginning in providing a meaningful education for talented students. A curriculum is needed to meet the specific needs of this unique group. Rather than describing the scaffolding of an existing program, Dr. Kevin Bartkovitch concentrated on the content within the structure, especially on student motivation. Building and sustaining student motivation is key to creating productive scientists and mathematicians.

Bartkovitch identified three ways to develop and maintain motivation among talented students: interesting content, appropriate rate of instruction, and strong peer networks. Course content should be dynamic and interesting, providing students with intellectual challenge. Students need to be provided with problems requiring sustained effort; information should be used to synthesize and integrate a wide range of knowledge. Adapting instruction to talented students involves a combination of acceleration and enrichment teaching.

Instructors of gifted students should have a knowledge base which extends beyond the scope of the current course so that they are capable of answering complex questions. Good teachers are characterized by a willingness to admit their own ignorance, and by the ability to combine this quality with a desire to learn. In addition, good teachers are characterized by a willingness to be flexible to the students' needs, allowing for the exploration of student interests independent of the course content.

The second way to enhance motivation is to provide instruction at an appropriate rate. Gifted students are quick to acquire facts; they need less time than their peers to assimilate discrete pieces of information. By presenting talented students with material which requires engagement, either through novelty of content or difficulty level, students maintain an active relationship with learning. However, providing appropriately paced materials for students with differing ability levels requires time and hard work. Regular classroom teachers need support for their efforts to provide appropriately paced instruction for students, especially as this generally entails extraordinary efforts to locate materials which are challenging to bright students.

The third key to generating motivation is the development of a strong network of intellectual peers. Developing contacts among bright students stimulates motivation in two ways: through forming friendships with peers with like interests, and through creating a challenging and competitive academic environment. Students are motivated when they find friends whose interests and abilities justify and validate their own; the presence of intellectual peers can challenge students to enlarge the scope of their own potential. When faced with a situation in which they are not automatically the best or the smartest, these students can become motivated to excel on the same level as their equally bright friends. Peer networks can form almost instantaneously and often last a lifetime.

Each of the two respondents to this presentation focused on a specific topic: Burton Stuart focused on finding appropriate levels of instruction; Solomon Garfunkel, on using interesting materials to stimulate motivation for learning.

Recognizing that the greater proportion of accelerated students are successful in advanced classes, Stuart pointed to a number of students for whom acceleration decreased, rather than increased, interest in mathematics. Overplacement of students in the study of mathematics may cause frustration from the inability to keep pace with the class. This, in turn, may actually inhibit further study in the subject. A major contributor to the overplacement of students in mathematics is the early identification of mathematics talent. Students who perform well in arithmetic in the sixth grade may not be as capable in higher levels of mathematics, which requires different cognitive skills. One possible solution may be that mathematics talent be identified only after higher level mathematics is introduced into the curriculum.

Two other problems were discussed in this response: poor mathematics education in elementary school and insufficient parent involvement. Elementary school mathematics education is deficient in part because of poor teacher preparation and unnecessarily slow curricula. Elementary school mathematics and science teachers often lack both expertise and motivation. The lack of competence inevitably has a detrimental effect on the interest level of students. The pace of instruction is slow, because of poor teacher preparation and teachers' low expectations of elementary-aged students' abilities. This slow pace contributes to the learning gap observed between students in the United States and other countries.

As the second respondent to Bartkovitch, Garfunkel discussed the topic of stimulating motivation through the use of engaging materials. He suggested that if material is presented in an interesting manner, students will be motivated to continue to study the subject. Interest in mathematics can be enhanced by providing students with engaging problems which incorporate real life situations that are fun, exciting, and open-ended. These problems, besides capturing students' interest, can bring enjoyment and motivation to the teacher. Mathematics problems presented to gifted students are best when they are structured to be approached from several directions. Problems requiring synthesis of information from different fields are also desirable, as they reflect the numerous uses of mathematics in many subjects.

The presenters on the subject of curriculum for gifted students emphasized the need to move away from pedantic and didactic instruction for students talented in mathematics, science and technology, and toward curricula that are creative and flexible. Although curricula, like programs, need to be tailored to the learning situation, certain elements must be incorporated. These are scope and challenge in the structure of the curriculum, active exploration of material, and problems which represent real world occurrences rather than artificial applications. Preferably, the solution of these problems will require a synthesis of information from diverse disciplines.

The curriculum will be best presented by teachers who are well qualified, who are themselves engaged in life-long learning, and whose level of expertise extends beyond the scope of the specific curriculum. Providing support for these teachers is essential. Both time and money are needed to enable teachers to search out materials which could extend and expand the regular curriculum for the gifted child. These materials are especially important for students who have advanced beyond their classmates and yet are not prepared to accelerate to a higher level. Through the use of these techniques, the curiosity which is so important to later productivity can be maintained and enhanced, helping to ensure the involvement of these students in careers which involve mathematics, science and technology.

Increasing Minority Representation among Talented Students

Programs such as CTY and IMSA are successful in providing programming for students with demonstrated talent; however, several conference participants (e.g., Tressel and Malcolm) reported that the nation's talent pool is changing. Females and minorities will in the future make up a large part of the nation's work force. Unless the representation of these groups among talented students also increases, the resource of talent available to the country will decrease. Both females and minorities are currently underrepresented among mathematicians, scientists and engineers. Therefore, students from these groups need encouragement, training, and opportunities to allow their talents to flourish. Part of the problem of underrepresented students could be solved through active recruitment of already qualified minority students. Another question is how to reach talented students whose environment suppresses the full expression of talent. One productive area of research maybe to investigate the characteristics of students who overcome adverse environmental circumstances and achieve at a level comparable to their more fortunate peers.

Judith Griffin, President of A Better Chance, Inc. (ABC), spoke about the mission of the ABC program, to "substantially increase the number of well-educated minority people who can assume positions of responsibility and leadership in American society." The program is dedicated to increasing the representation of minorities, especially black students, among the nation's professionals. The success of the program has made it a resource for others interested in increasing the participation of minority students in programs for talented youth.

Minority students face a myriad of barriers as they enter the educational arena: the problem of low socioeconomic status is often compounded by inadequate financial aid, peer pressure against academic achievement, the lack of advocacy or active recruitment by school faculty, and low expectations for achievement. The combined result of these and other barriers is inappropriately low scores on standardized achievement tests, regardless of potential ability.

Several aspects of ABC's program distinguish it from other efforts to recruit minorities. One of the unique components is the active participation of member schools, a consortium of independent college preparatory schools committed to providing education to talented minority students. Combining the identification of talent and placement with cooperating schools provides a coherent effort which forms the basis of the success of the ABC program.

Part of ABC's mission is to find alternative methods of identifying talent. Analyses demonstrate how their selection criteria are related to later success. The comprehensive assessments made by the ABC staff, which combine recommendations and student test scores, were the best predictors of later success in programs. Standardized test scores alone were the weakest predictors. Other studies have indicated that ABC alumni are as likely to select careers in mathematics and science as students in the general population, a proportion substantially larger than usually found among minority students. Results of surveys of the alumni of the ABC program indicate that the basic premises of the program are correct: through the use of alternative identification procedures and with appropriate support, minorities can succeed at the most rigorous levels of American education.

The second response, by Belvin Williams, focused on the problems encountered when using a standardized test as the primary means of identifying talent. Williams cited several reasons why standardized test scores may be suspect:

1. Although a high score on an achievement test indicates potential success in college, the meaning of a low score is not clear: low scores on achievement tests do not indicate "no aptitude."

2. Achievement tests measure only a limited range of the cognitive skills considered necessary for success in college.

3. Several sources of measurement error enter into the accuracy of prediction of test scores, including error in test construction and in the criteria selected as the operational definition of talent.

4. The assumption that the statistical function relating test scores and other criteria of talent is linear may be false. The statistical relationship between test, criteria, and success could take many forms, and is unlikely to be as clear-cut as suggested by the use of linear functions.

Williams also addressed the issue of how to increase the representation of minorities in the talent pool. Even though existing programs have very few false positives among their minority recruits, an overwhelmingly large number of false negatives occurs among the minority population--many students are not admitted into special programs even though they are capable of success. The question this problem raises is how to find a cost effective and efficient means to broaden the scope of the admissions process. The success of the ABC program suggests that minority students achieve best when they are associated with an adult who believes in their capacity to excel. The inclusion of teacher recommendations as a means of identifying students with exceptional ability may be an effective means of locating talented students and alerting teachers to the possibility that there may be talented students in their classes.

Maxine Bleich described an effort similar to that of ABC, but funded by the Josiah Macy Foundation. The Macy Foundation sponsors several support systems designed to encourage minority participation in the study of medicine, including establishing Offices of Minority Affairs in over half of the nation's medical schools and supporting excellence in traditionally black undergraduate schools. In 1980 the Foundation implemented the Minorities in Medicine program in secondary schools. At the program's inception the Foundation planned to select project schools in which exemplary academic programs would be developed. The focus of the programs would be to provide minority students with an excellent overall academic background, with a particular view to later involvement with medicine. The Macy Foundation provided the funds to establish high quality, academically rigorous education in the impoverished neighborhoods using a traditional educational format: four years each of mathematics, science, social studies, and language arts. Students received training in study skills prior to entering the program. After several years, program evaluations indicate broad-based success. Not only have students progressed academically beyond expectations, but teachers' and administrators' expectations of their students have improved.

Procedures especially effective for the ABC program included the use of teacher and counselor recommendations and personality characteristics of the students. Again, the importance of the study of characteristics unique to gifted students becomes apparent. The concept of combining standardized achievement measures with personality characteristics to identify talent was prevalent among conference presenters. Sherburne presented data indicating that only a subset of academic achievers become creative producers; Perkins spoke on the importance of precursor abilities on later achievement; Zigler emphasized the unique personality characteristics which contribute to the presence of giftedness. To increase the pool of talented adults entering the work force, programs for gifted students will have to incorporate some of these methods of identifying talented students.

Summary

Developing programs for talented students requires tailoring programs to students' needs. Although all programs are different, certain characteristics are common to all. A belief system, or program philosophy, provides a cornerstone upon which all other programming decisions are made. All of the programs described at the conference support flexible and individualized programming for talented students. Beyond this, each subscribes to a different belief system which sets the respective goals and priorities.

These different, though not mutually exclusive kinds of programs include:

1. Providing rigorous supplementary programs for students;

2. Providing experiential education; and

3. Supporting talented minorities in their drive for quality education.

Contributors to the discussion of program emphasized that an effective program needs a dynamic and interesting curriculum to stimulate the curiosity of students; a good curriculum provides information which is engaging, relevant, and open-ended; the process of problem finding should be emphasized along with problem solving. Real experiences either in laboratories or in real working environments add to classroom learning. Most importantly, talented students need teachers who are well trained, engaged in learning, and sympathetic to the characteristics of talented students.

The primary goals of any program for the gifted is essentially the same--to provide quality education for talented students and to create an intelligent and productive adult. The programs presented at this conference far from exhaust the number of quality programs currently engaged in the endeavor to fulfill the potential of talented students. Continuing to develop creative and diverse programs is the way educator scholars and practicioners will be able to meet the needs of any population of talented students.

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