DOCUMENT RESUME

ED 371 559 EC 303 147

AUTHOR Pyryt, Michael C.
TITLE Helping the Scientifically Gifted.
PUB DATE Sep 93
NOTE 5p.; In: Nurturing Potential, Proceedings of the Society for the Advancement of Gifted Education Annual Conference; see EC 303 142.
PUB TYPE Speeches/Conference Papers (150) -- Guides - Non-Classroom Use (055)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Ability Identification; Academic Achievement; *Academically Gifted; Acceleration (Education); *Educational Methods; Elementary Secondary Education; *Enrichment Activities; Foreign Countries; Mentors; Science Curriculum; Science Education; *Student Development; Teaching Methods

ABSTRACT

This presentation summarizes effective strategies and programs for nurturing students who are gifted in science. A smorgasbord of educationally accelerative opportunities is recommended, to enhance students' potential for future development in science. These opportunities may include field trips, advanced placement courses, and science summer camps. Experiences that promote science achievement are described, such as simultaneous teaching of separate science subjects. Models for encouraging scientific development, such as early entrance to college and contests/competitions, are cited. Recommendations are offered for nurturing talent in science and technology. Recommendations relate to the topics of identification, science curriculum, and teachers/mentors. (Contains 15 references.) (JDD)

Helping the Scientifically Gifted

Michael C. Pyryt
The University of Calgary

The purpose of this presentation is to summarize effective strategies and programs for nurturing those gifted in science. The basic assumption is that "no single formula can be developed which can be followed by all schools and all science classes" (Passow, 1957, p.112). Rather a smorgasbord of educationally accelerative opportunities (Stanley, 1979) should be available to enhance a student's potential for future development in science. Some items such as field trips might be thought of as appetizers, which are intended to spark an interest in science. Rigorous content-oriented curriculum such as Advanced Placement Biology would be the main course for some students. Participation in special science summer camps might be thought of as desserts that reward dedication throughout the school year. The decision regarding which item(s) from a variety of possible educational opportunities are most appropriate for a given student is a complex one which must be based on the characteristics of the learner (aptitude/achievement patterns, interests, level of motivation, career goals, developmental level, and socio-cultural conditions), the nature of the discipline (content knowledge, methodological skills, and personal traits needed to be a skilled practitioner), and the nature of the instructional option (goals, instructional activities, and staff competence).

Lessons from the sociology of science, psychology of eminence, and research in science education provide insights into the experiences that promote effective science achievement.

From the sociology of science (Zuckerman, 1977), it is possible to trace the career pathway of Nobel Prize winners. Future Nobelists attend elite undergraduate institutions. Successful performance at these elite schools leads to attendance at elite graduate schools with Nobel Laureates as supervisors. More than the content knowledge the future nobelists learn at these elite schools, they are socialized to think and behave as a scientist. This experience leads to publication in prestigious journals and subsequent recognition and promotion at elite institutions.

From the psychology of eminence, it is possible to gain insights into the stages of scientific process. Mansfield and Busse (1981) extended Wallas' (1926) Stages of the Creative Process (Preparation, Incubation, Illumination, and Verification) include the notion of constraints or barriers to scientific discovery. According to their model, scientific breakthroughs occur by chaining empirical, theoretical, or methodological constraints.

Research in science education provides insights into factors affecting science curriculum. Achievement results from the Second International Study of Science Achievement indicated that students from industrialized countries with lower population growth had the highest science achievement. Other correlates of science achievement included early concentration of science content, simultaneous teaching of science content (teaching biology, chemistry and physics as separate subjects at the same time, which is different from Alberta's Science 10 integrated curriculum), studying a few subjects at the high school level, and having a low percentage of the age group in school (Keeves, 1991; Postlewaite, 1991). Results of meta-analyses of practices in science education indicate that innovative science curriculum improves science achievement about 1/3 of a standard deviation (Weinstein, Boulanger, & Walberg, 1982; Shymansky, Kyle, & Alport, 1983). Instructional systems on the average only improve achievement 1/10 of a standard deviation. The effective instructional systems were mastery learning and the personalized system of instruction which improved achievement .64 and .60 standard deviations respectively (Willet, Yamishita, & Anderson, 1983).

There are a variety of models for encouraging scientific development. These include early entrance to college, part-time college courses, Advanced Placement, the use of Diagnostic Testing/ Prescription Instruction (DT/PI) to facilitate Fast-paced scientific courses, specialized schools, extension programs and contests/competitions. Each of these approaches has support in the research literature. They focus on content acquisition, socialization as scientists, and provide opportunities for higher level scientific training.

RECOMMENDATIONS FOR NURTURING TALENTS/GIFTS IN SCIENCE AND TECHNOLOGY

An analysis of exemplary programs in China, Russia, and the North America in conjunction with the insights from the sociology of science, psychology of eminence, and science education provides a knowledge base for making recommendations regarding the discovery and development of gifts/talents in science. These recommendations relate to the topics of identification, science curriculum, and teacher/mentors.

Identification

The use of talent searches, olympiads, entrance examinations, and science fairs provides the opportunity for scientifically gifted students to demonstrate their ability in science and technology. These identification practices permit the opportunity for self-selection since students' participation is voluntary. Formal examinations should focus specifically on scientific content. Since mathematical reasoning ability facilitates the acquisition of scientific concepts, the identification of mathematically precocious youth through measures such as SAT-M is also beneficial.

Science Curriculum

Science curriculum should provide the opportunity for advanced study of scientific concepts and methodology. Students should know both the content of various scientific disciplines and the processes scientists use to discover knowledge. Students should be given the opportunity to conduct original research projects. In addition to conducting research, students need to have the opportunity to communicate the results of their research by presenting at seminars and conferences and by writing articles for publication in journals.

During secondary schooling intensive coursework in mathematics and science taught at an accelerated pace should be coupled with adequate coursework in the humanities and social sciences. This training will provide a solid foundation for majoring in physics, chemistry, or biology as an undergraduate.

There is also a need for the science curriculum to address the ethical dilemmas that scientists face (Passow, 1957, 1988b; Pyryt, 1979; Tannenbaum, 1979). This need has been stated most eloquently by Tannenbaum (1979), who quotes Commoner's (1966) warning that " no scientific principle can tell us how to make the choice, which may sometimes be forced upon us by the insecticide problem between the shade of the elm tree and the song of the robin" (p. 104). The well-known instances of computer virus epidemics provide another example of the need for gifted individuals to use technology as a productive rather than destructive force.

Teachers/Mentors

All of the successful programs for nurturing gifts/talents in science and technology acknowledge the importance of the teacher. Passow (1957) identified the following characteristics as exemplifying a quality science teacher: is inspired and inspiring; knows science and its techniques; understands the meanings of science and its relationship to the world, encourages individual excellence; guides the student to locate resources; adapts teaching methods to stimulate problem solving; attempts to provide flexible programming to meet the unique needs of rapid learners.

Mentorship experiences provide students the opportunity to learn the nature of the discipline by personal contact with a practicing professionals. Through such experiences, individuals are socialized into the processes scientists use as well as their work habits, attitudes, and values. Exposure to appropriate role models seems especially beneficial for scientifically gifted females (Tobin & Fox, 1980).

Providing scientifically talented individuals with challenging curricula, and effective teacher/mentors is the key to nurturing their gifts/talents.

References

Commoner, B. (1966). *Science and survival*. New York: Viking.

Keeves, J. P. (1991). Specialization in science: 1970 and 1984. In T. Husén & J. P. Keeves (Eds.), *Issues in science education: science competence in a social and ecological context* (pp. 65-105). Oxford: Pergamon.

Mansfield, R. S., & Busse, T. V. (1981). *The psychology of creativity and discovery: Scientists and their work*. Chicago: Nelson-Hall.

Passow, A. H. (1957). Developing a science program for rapid learners. *Science Education, 41*, 104-112.

Passow, A. H. (1988). The educating and schooling of the community of artisans in science. In P.F. Brandwein & A. H. Passow (Eds.), *Gifted Young in science: Potential through performance* (pp. 27-38). Washington, DC: National Science Teachers Association.

Postlethwaite, T. N. (1991). Achievement in science education in 1984 in 23 countries. In T. Husén & J. P. Keeves (Eds.). *Issues in science education: Science competence in a social and ecological context* (pp. 35-59). Oxford, UK: Pergamon.

Pyryt, M. C. (1979). Helping scientifically gifted children. *Science and children, 16*(6), 16-17.

Shymansky,J. A., Kyle, W. C., & Alport, J. M. (1983). The effects of new science curricula on student performance. *Journal of Research on Science Teaching, 20*, 387-404.

Stanley, J. C. (1979). The study and facilitation of talent for mathematics. In A. H. Passow (Ed.). *The gifted and talented: their education and development* (pp. 169-185). (Seventy-eighth Yearbook of the National Society for the Study of Education, Part I.) Chicago: University of Chicago Press.

Tannenbaum, A. J. (1979). Pre-Sputnik to post-Watergate concern about the gifted. In A. H. Passow (Ed.), *The gifted and talented: Their education and development* (pp. 5-27). (Seventy-eighth Yearbook of the National Society for the Study of Education, Part I.) Chicago: University of Chicago.

Tobin, D., & Fox, L. H. (1980). Career interests and career education: A key to change. In L. H. Fox, L. Brody, & D. Tobin (Eds.), *Women and the mathematical mystique* (pp. 179-191). Baltimore: The Johns Hopkins University Press.

Wallas, G. A. (1926). *The art of thought*. London: Watts.

Weinstein, T., Boulanger, F. D., & Walberg, H. J. (1982). Science curriculum effects in high school: A quantitative synthesis. *Journal of Research in Science Teaching, 19*, 511-522.

Willett, J., Yamashita, J. J. M., & Anderson, R. D. (1983). A meta-analysis of instructional systems applied in science teaching. *Journal of Research in Science Teaching, 20*, 405-417.

Zuckerman, H. (1977). *Scientific elite: Nobel laureates in the United States*. New York: Free Press.