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ABSTRACT

This framework provides an overview of the emerging literature on the gender gap in science. It seeks to contribute to the growing body of research emphasizing factors that have been shown to enhance women's ways of knowing; thereby transcending gender stereotypes in science. The theoretical and research bases of gender issues in science are outlined and a framework for analyzing research findings within the contexts of individual, community, family, and school is presented. Implications for improvement of educational practice and policy development are drawn and collaborative roles for educators, parents, schools, and community members are suggested. Contains 88 references. (Author)

The Resilience of Girls in Science: A Framework

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RUNNING HEAD: The Resilience of Girls in Science

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Abstract

This framework provides an overview of the emerging literature on the gender gap in science and seeks to contribute to the growing body of research emphasizing factors that have been shown to enhance women's ways of knowing in science; thereby, transcending gender stereotypes in science. It outlines the theoretical and research bases of gender issues in science, and posits a framework for analyzing research findings within the contexts of individual, community, family, and school. Implications for improvement of educational practice and policy development are drawn, and collaborative roles for educators, parents, schools, and community members are suggested.

The Resilience of Girls in Science: A Framework

Introduction

Since the work on science achievement was instigated by the findings of the 1976-1977 National Assessment of Educational Progress Second Survey of Science, researchers have been investigating factors that have contributed to the gender gap in science, and intervention programs have been developed to narrow the gender gap. While these accomplishments have been significant, the gender gap in science remains (Kahle & Meece, 1994). Research has demonstrated that gender gaps in science achievement start as early as 9-years-old (American Association of University Women, 1992; Mullis & Jenkins, 1988). Efforts during the past two decades to narrow the gender gap in science have produced very little change (Bailey, 1996; Blake, 1993; National Science Foundation, 1990; Task Force on Women, Minorities, and the Handicapped in Science & Technology, 1989). Furthermore, the focus on the barriers girls face in science have become an obstacle in the quest for fostering the resilience of girls in science. In particular, the barriers girls face in science often overshadow the very characteristics girls hold that promote their resilience to achieve in the actual practice of science. Characteristics such as seeking personal relevance, working cooperatively, valuing interdependence; and having keen observational, verbal, and writing skills (AAUW, 1990; Baker & Leary, 1995; Foster, 1985; Gilligan, 1982; Keller, 1985; Rosser, 1990; Kruschwitz & McClintock Peter, 1994; Lazorowitz, 1988; Okebukola, 1986). By finding ways to focus on the resilient characteristics girls hold that enable them to achieve in science, we can improve the capacity of science in our schools and enhance the schooling success of <u>all</u> students in science.

This framework provides an overview of the emerging literature on the gender gap in science and seeks to contribute to the growing body of research emphasizing factors that have been shown to enhance women's ways of knowing in science; thereby, transcending gender stereotypes in science. It outlines the theoretical and research bases of gender issues in science, and posits a framework for analyzing research findings within the contexts of individual, community, family, and school. Implications for improvement of educational practice and policy development are drawn, and collaborative roles for educators, parents, schools, and community members are suggested.

Theoretical and Research Bases

There is increasing evidence that the gender gap in science may be better understood in terms of the perceived masculinity of science, thus impacting on the learning styles of girls and the current instructional patterns of teaching science in schools (Bleier, 1984; Harding, 1986; Kahle & Meece, 1994; Keller, 1985,1986). The assertion is that the learning style of girls does not align itself with the practice of science. The organizational characteristics of science - such as its competitive and individualistic nature, objectivity, value-free inquiry, and isolated enterprise - play important roles in diminishing the resilience of girls in science (AAUW, 1990). According to Kelly (1985) the perception that science is a masculine domain discourages girls interest in science; therefore, from choosing science as an area of study, from achieving in science, and from continuing to study science. Other researchers share this perception as a barrier to girls expressed interest in science (Baker, 1990; Shroyer, Powell, & Backe, 1991).

Research has reported that girls and boys have vastly different science-related experiences inside and outside school that contribute to the gender gap in science achievement (Bailey, 1993; Kahle & Lakes, 1983; Linn, 1990; Rosser, 1990; Sjoberg & Imsen, 1988). Indirect and direct experiences that contribute to such differences include: playing with scientific games and toys (Astin, 1974; Casserly, 1980; Hilton & Berglund, 1974; Maccoby & Jacklin, 1974); participating in science activities at home (Kahle & Lakes, 1983; Mullis & Jenkins, 1988); taking science-related field trips (Kahle & Lakes, 1983); parental stereotypic behavioral expectations (Hoffman, 1977; Morgan, 1992);

expectations for independence (Block, 1978; Hoffman, 1972); and parents educational and vocational aspirations (Adelman, 1991; Brody & Fox, 1980). Despite having different experiences, some girls succeed academically in science despite the adverse circumstances (Bailey, 1996). It has been shown by research that when boys and girls take the same amount and kind of science courses, girls on average tend to out perform boys (Adelman, 1991; Kahle & Meece, 1994; Mullis & Jenkins, 1988; NAEP, 1987). Research suggests that it is not that girls can not and do not have the ability to succeed in science; but obstacles arise in recruiting and retaining girls in science (Kahle & Meece, 1994).

It seems logical to expect that girls attitudes and interest in science can be fostered by instructional methods that demasculize and demystify science, promote women roles models and career information, implement instructional strategies that actively involve girls in science, and foster girls skills of doing science while encouraging girls' self-confidence and self-perceptions of their ability to do science. Research has documented that these factors play a significant role in promoting success in science for girls (Association of American Colleges, 1982; Blake, 1993; Bleier, 1984; Evans, et al. 1995; Harding, 1986; Kahle & Meece, 1994; Keller, 1985,1986; Wilson & Milson, 1993). Although such factors must remain a primary focus of efforts to increase girls attitudes and interest in science; it may be time to shift our focus to instead of thinking in terms of gender differences that focus on the barriers girls face in science, to expanding our concept of learning and teaching that transcends the gender barriers (Bailey, 1996; Shakeshaft, 1975; Tovey, 1995).

What must be considered are students individual differences and to integrate a broad range of teaching and learning strategies in classrooms that account for such differences across gender (AAUW, 1990; Versey, 1990). In this broader conceptual view learning is fostered not by promoting gender specific strategies but by promoting learning experiences for all students. When focusing on the individual, community, family, and school; the resilience of girls in science achievement, thus their recruitment and retention, provides an important conceptual base for the design of educational interventions and can be used to inform theory, practice, and policy.

The Role of the Individual, Community, Family, and School

The Role of the Individual

One proposed barrier to gender differences in science achievement has been attributed to spatial visualization tasks (Fennema & Sherman, 1977). While it has been documented that gender differences appear in some measures of cognitive abilities, their influence on students' achievement in science has not been well established and are considered to be minimal (Linn & Peterson, 1985; Linn & Hyde, 1989). Research has documented the role that intervention can play in minimizing gender differences (Conner, Schackman, & Serbin, 1978; Liben & Golbeck, 1980, 1984; Whyte, 1986).

A second barrier is seen in the number of college preparatory courses women and men take. Although fewer women then men may take a college preparatory curriculum in science, the women who do tend to perform better than men in science classes (Adelman, 1991; Kahle & Meece, 1994; Mullis & Jenkins, 1988; NAEP, 1986). Thus, to the extent that boys and girls do differ in their ability to perform spatial tasks, this difference alone does not sufficiently explain gender differences in science achievement.

Another proposed barrier is seen in gender achievement on the SAT or ACT. Hyde et al. (1990) suggests that such gender differences are the result of the selectivity of the sample. Males tend to come from a more selective background in terms of parental income, father's education, and attendance at private school (AAUW, 1992; Hyde & Linn, 1988; Leibowitz, 1977). Adjusting for these selective differences in comparison of scores on the SAT or ACT the gender differences disappear (Adelman, 1991). What is often ignored or dismissed in research on science achievement is that girls tend to be at the top of their high school graduating class in science (Kahle & Meece, 1994).

Research on attitudinal variables effect on girls' achievement in science have not been well founded (Fleming & Malone, 1983; Halalyna & Shaughnessey, 1982; Steinkamp

& Maehr, 1983, 1984; Wilson, 1983). Overall, gender differences in science attitudes are larger for measures that assess self-concepts of science ability than those that focus on interest, importance, and enjoyment (Steinkamp & Maehr, 1984). Variables that have been shown to affect gender attitudes toward science are ability level, age related, geographic location of school, socio-economic background, and race or ethnicity (Campbell, 1991; Matyas, 1984; Simpson & Oliver, 1985; Steinkamp & Maehr, 1983, 1984; Wilson, 1983). All available evidence suggests that gender differences in affective variables cannot adequately explain the under representation of women in science (Kahle & Meece, 1994). The research does demonstrate that some girls do achieve in science despite the barriers and has revealed that such resilient girls who achieve in science tend to be motivated, independent, resourceful, self-determined, and possess good cognitive spatial ability (Kahle & Meece, 1994).

The Role of the Community

Community plays an important role in developing resilience in science among girls. The sociocultural stereotype of the masculinity of science affects girls' identification with science and pursuing science as an avenue of study (Baker, 1990; Bleir, 1984; Harding; 1987; Kahle & Meece, 1994; Keller, 1985,1986; Kelly, 1985; Shroyer, Powell & Backe, 1991; Versey, 1990). Kelly (1985) identifies three ways that community defines and influences the image of science as a masculine enterprise: numbers of who practice and are rewarded in science; the way science is perceived in curriculum and instruction; and the way science is practiced in and outside of school.

Research has shown that communities that recognize science as a neutral enterprise in and out-side of school, encourage girls to pursue science as an avenue of study, provide out-of-school hands-on science activities for girls, and highlight women as role models in science provide fostering environments for girls to explore their interest in science, achieve well in science, and continue to study science (Kahle & Meece, 1994). The linking of parent, school, and community resources heightens the resilience of girls interest and achievement in science.

The Role of the Family

Research on the role of the family in the resilience of girls to achieve in science has documented the importance of parental behavioral expectations for their daughters have important long-term implications (Adelman, 1991; Astin, 1974; Block 1978; Brody & Fox, 1980; Casserly, 1980; Eccles, 1989; Eccles, Adler & Kaczala, 1982; Hilton & Berglund, 1974; Hoffman, 1972,1977; Huston, 1983; Kahle & Lakes, 1983; Maccoby & Jacklin, 1974; Mullis & Jenkins, 1988; Tracy, 1987). Families that hold less gender-stereotypic views for their daughters personal characteristics, educational attainment, and occupational roles have been shown to effect girls educational aspirations, higher self-esteem, and career orientation, notable of girls of employed mothers (Eccles & Hoffman, 1986). In addition, family background variables such as ethnicity, socioeconomic status, and parental education are assumed to have an indirect effect on girls' science achievement through their influence on the availability of economic resources, the quality of the home environment, level of parents' educational and occupational aspirations, and the quality of the schools attended (Hueftle et al., 1983; Mullis & Jenkins, 1988; Schibeci & Riley, 1986; Simpson & Oliver, 1990; Vetter & Babco, 1989; Ware & Lee, 1988).

Gender role socialization within the family maybe directly linked to gender differences in science achievement. Families that foster the participation of girls in science activities at home may encourage girls achievement in science. Family involvement in school science programs has been shown to enhance girls' achievement in science (Hammrich, 1996). Intervention science programs for girls specifically designed to include families have a strong and positive impact on girls achievement in science. Fostering family involvement in science programs designed for their daughters helps girls identify with science as a possibility.

The Role of the School

The synthesis of research on the role of the school has found a consistent pattern of organizational and behavioral characteristics among schools and classrooms that promote resilience of girls in science interest and achievement. The following variables are part of a research framework base that focuses on strategies that enhance a schools' ability to promote girls resilience and achievement in science.

Teacher expectations and behaviors. Teachers play an important role in promoting girls resilience and achievement in science (Campbell, 1996; Kahle, 1985). Teachers in more effective schools tend to demasculinize and demystify science by presenting science as a subject that everyone can learn (Kahle, 1985; Rosser, 1990). Teachers help girls foster interest and attitudes necessary for achieving in science by exposing girls to role models and career information; implementing instructional strategies that actively involve girls in science lessons; actively promote and foster girls' skills of doing science; supporting girls science endeavors by encouraging their interactions in and out of the classroom; and fostering girls' sense of competence and positive self identity in science (Danzl-Taver, 1990; Kahle, 1985; Kahle et al, 1991; Kelly, Whyte, & Smail, 1984; Klanin & Fensham, 1987; Mason & Kahle, 1989; Rennie and Parker, 1987; Smail, 1985; Versey, 1990; Whyte, 1986).

Type of instruction. Of particular relevance to girls resilience in science is instruction that promotes a more active role in cooperative, rather than competitive, learning activities (Baker, 1990; Eccles, 1989; Johnson & Johnson, 1987; Kahle, 1990; Smail, 1985). The cooperative centered focus tends to engage girls in a more active role in the classroom by promoting positive attitudes toward instruction, mastery of content, and self-esteem. Also instruction that views learning as a constructivist approach empowers girls preferred learning styles by forging closer connection between science and girls lives tend to increase the resilience of girls interest and motivation in science by providing a sense of purpose (Scantlebury & Kahle, 1991).

Classroom interactions. Interactions in the classroom are of particular importance in fostering girls resilience and interest in science. Interaction strategies that promote a sense of equality include using non-biases language, alternating questions between girls and boys, extending wait-time for answers, and using examples that reflect the interests of girls (Gallagher & Tobin, 1987; Kelly 1985; Scantlebury & Kahle, 1991; Tobin & Garnett, 1987).

Classroom Climate. A Classroom climate that is sensitive to creating an environment where girls feel "empowered" tend to increase girls connection to science. Such an environment is one that recognizes and values all students opinions, promulgates a cooperative rather than a competitive learning environment, encourages girls to be active in the classroom, posits science as a natural extension, and shows the connection of science to the student lives (Humrich, 1988; Linn, DeBenedictis, Delucci, Harris, & Stage, 1987; Murphy & Qualter, 1986; Scantlbury & Kahle, 1991;).

Curriculum. Curriculum that shows and promotes the relationship between science and girls lives, provide non-sex biased depiction of women and men in science and language tend to increase the resilience of girls interest and motivation in science (Kahle, 1990; Rosser, 1990). Curriculum and assessment instruments that are gender neutral or emphasize female interests tend to not alienated girls by being responsive to cultural and individual differences (Scantlebury & Kahle, 1991).

Out of School Activities. Encouragement of girls participation in out of school activities in science build self-confidence, a positive science self-concept, and promote enjoyment with science fosters girls resilience in science. Out of school activities that actively involve girls in science promotes a sense of empowerment.

Conclusions and Implications

Assumptions about how girls learn and achieve in science are often limited by focusing on barriers girls face in science to the exclusion of the resilient characteristics girls hold that promote their success in science (AAUW, 1990). All students learn differently through a range of skills; what works for girls may very well work for boys and vice versa. By focusing on all too stereotypic gender learning styles we may be deepening the gender stereotypes and narrowing our focus on teaching and learning. What we should be asking ourselves as educators is what works for the individual student? What can we provide the students that will encourage their resilience? Broadening our definitions of learning and teaching and expanding our concept of the range of skills all students can achieve. In the real world, things are not always one way or another and we don't expect that everyone is the same; perhaps the time is now to start considering individual differences instead of pitting one gender-centered model against the another.

Shifting the focus from gender to the needs of the individual students does not diminish the gender equity research of the last 20 years. The resilience of girls in science needs to be further researched to shed light on our broadening approach to learning and teaching. The framework sought to engage in such an endeavor by transcending gender stereotypes and focusing on the resilient strategies of girls in science. To this end, the framework offers the following implications as a challenge to gender equity researchers in promoting the resilience of girls in science.

1. The emerging research on the resilience of girls in science represents a major paradigm shift from the obstacles and barriers girls face in science to studies of correlates of resiliency of girls in science by fostering interventions that promote girls in science.

2. Research that focuses on the promotion of the resilience of girls in science by recognizing and analyzing research findings within the contexts of the individual, community, home, and school utilizes a framework that identifies positive characteristics that lead to the resilience of girls in science.

3. Girls resilience in science offers a challenge to researchers and practitioners, and suggests the potential benefits of girls inclusion in science in and out of the school context. It also stipulates that the inclusion of girls in science strengthens girls to pursue science as a possibility.

4. Research on the resilience of girls in science will help researchers and practitioners formulate better well informed intervention measures. However, the argument over such resilience of girls in science has been built upon short term research and intervention practices that are sometimes not in agreement, calling for the need to probe the validity of the construct over extended periods of time and in multiple contexts.

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