A New Look at Gender Equity Professional Development for Secondary Science/Mathematics Teachers and Counselors

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Abstract

WISE Investments (WI) is a four-year National Science Foundation project HRD 98 72818 designed for secondary science/mathematics teachers and counselors to enable them to help interest young women in engineering. A component of the WI program is gender equity training. Although the gender equity professional development module improved each year, the program coordinators thought that they could do better. In particular, teachers requested more applications and classroom strategies than statistics. In the fourth WI, a new approach to the gender equity presentation was taken by enlisting three Ph.D. science education majors and one Ph.D. education policy and leadership major. These four students all had recent and extensive experience in teaching K-12 science, thus had a natural understanding and empathy of the needs and everyday challenges of the teachers and counselors in the WI program.

The training was organized around practical applications of gender equity in curriculum, instruction, and classroom climate. The PhD student team used expert teaching methods to gain credibility with the participants and to model best practices in instruction. Rather than reciting research, a gender equity assessment tool was designed to present the current findings in the literature and to evaluate the WI participants' awareness of gender equity. The PhD team then facilitated gender equity discussions with the teachers and counselors by soliciting examples from the group. Next, the participants worked in small teams to identify gender bias in textbooks and to examine biases in teacher-to-student interactions through a case study analysis. The group also viewed and discussed the teacher-to-student interactions shown in a video. The PhD team also devised specific strategies to improve curriculum, instruction, and classroom climate for girls. The teacher and counselor WI participants further brainstormed and personalized these strategies for immediate implementation in their classrooms.

This paper will present the agenda for the successful three-hour workshop in two segments, the gender equity assessment tool, the guidelines for examining gender bias in textbooks, the interaction case study, and the classroom strategies to avoid bias and to promote gender equity in the classroom. Additionally, feedback from the WI participants on this training will be discussed.

Keywords: Gender Equity, K-12 Professional Development, K-12 Engineering Education

I. Introduction

WISE Investments (WI) is a four-year National Science Foundation (NSF) sponsored project designed for middle school and high school science/mathematics teachers and counselors to enable them to help interest young women in engineering. A major component of this project is to provide a two-week summer professional development workshop that introduces middle school and high school teachers and guidance counselors to engineering [1]. Engineering faculty are a key component in the summer workshop [2]. The K-12 educators are responsible for integrating what they have learned in the engineering workshops by using related activities in their mathematics and science curricula. The teachers and counselors practice the presentation of these modules on middle school and high school young women during Saturday Academies during the academic year [3]. The counselors are encouraged to include applied math and science in their career counseling and to implement outreach programs to encourage students to consider a major in engineering. To further enable the teachers and counselors, they are offered the helpful opportunity of a one-week industrial internship in order to have a better idea of what engineers really do day-to-day [4].

It is well known that very few women choose engineering as a career. Among Fall 2001 freshmen women, only 2.5% said that their probable career would be an engineer and only 1.4% said their probably career would be a computer programmer or analyst [5]. At the same time, 13.2% of the male freshmen said that engineering was their probable career and 8.3 % listed computer programming or analyst [5]. A main goal of this project is to have math and science teachers and counselors in the K-12 encourage young women to become interested in engineering and to have them consider engineering as a career for themselves. It is assumed that if engineering can be presented in a way that is interesting to young women, then young men will also become interested. An important component then of the WI program is gender equity training. Although the gender equity professional development module improved each year, the program coordinators thought that they could do better. In particular, teachers requested more applications and classroom strategies than statistics [6,7].

In the fourth WI, a new approach to the gender equity presentation was taken by enlisting three Ph.D. science education majors and one Ph.D. education policy and leadership major. These four students all had recent and extensive experience in teaching K-12 science, thus had a natural understanding and empathy of the needs and everyday challenges of the teachers and counselors in the WI program.

II. Gender Equity Training

The four presenters for the gender equity training were all doctoral students with strong interests and backgrounds in gender equity. Their preparation included working in the area of gender equity with their major professor (D. R. Baker) including dissertation research, class projects, proposal writing, manuscript reviewing and coursework. The coursework provided the foundation for all subsequent activities and consisted of reading the research in science education

and gender equity. Readings addressed the interests and values of girls and women, gender appropriate instructional strategies in science, gender fair assessment strategies, curriculum evaluation for balanced representation of women's contributions to science, and exposure to resources that would aid teachers in supporting girls' interests in science.

The summer workshop activities were grounded in this research base and experiences. The workshop instructors worked to increase awareness of gender equity and to provide the teachers with gender equity assessment and instructional tools. They also provided guidelines and practice examining curricular materials and helped teachers plan to use more equity materials and strategies in their classrooms. All presentations and activities were supported by strong rationales derived from the research literature on gender equity in science education.

III. Assessing What Teachers Want

In an effort to assess the gender-equity experiences the teachers had before the training, they were asked to complete a brief questionnaire. Six of the eleven participants returned the questionnaire prior to the workshops. Based on their responses, the doctoral students found five participants had 4-40 hours of previous training or exposure to gender equity issues. They were either offered this training as professional development through their school district or had taken an undergraduate or graduate-level university course that included gender equity issues. One participant had volunteer experience at a camp that promoted diversity, tolerance, and equity issues.

Five of the participants expressed interest in learning procedures to create gender equity in the classroom and asked for specific examples of gender differences in the classroom. Four of the participants were interested in the research and data that validates gender differences and resources that highlight the contribution of women in science and math. They also asked for examples of gender differences in business and other situations. Their responses to the questionnaire allowed the instructors to create a tailor made workshop that incorporated classroom application strategies, a background of the gender equity research, and provide additional resources that would help create a more gender equitable classroom. Figure 1 below outlines the agenda for the two sessions.

IV. Gender Equity Assessment Pre / Post

It was the experience of the instructor group that many teachers, especially females who have been successful in mathematics, science, and technology, deny that inequities exist in science and mathematics classrooms. To reveal to the teachers the current state of affairs and raise awareness of how females tend to be disenfranchised by decontextualized curriculum and didactic teaching methods, the workshop historically included a review of relevant gender equity research. Feedback from previous WISE teacher workshops included comments about the emphasis placed on the literature in the field of gender equity. The teachers were not particularly interested in the research that described the current state of affairs. They wanted specific strategies for curriculum development and classroom instruction that addressed gender inequities

Agenda Session 1
(1 hour)

I. Introduction of Presenters

II. Gender Equity Awareness Assessment

III. Video Part I *"Failing in Fairness"* Dateline NBC 1996
(Diane Sawyer with Myra and David Sadker)

IV. Review of Assessment & Video Discussion
How do you feel about this assessment? The video?

V. Classroom Strategies Handout:
Specific suggestions for achieving gender equity in your classroom

VI. Wrap-up: Comic Strip Activity Part I:
"Why we'll never understand each other!"

Agenda Session 2
(2 hours)

I. Warm-up Comic strip activity Part II:
"Why we'll never understand each other!"

II. Review of the Research
Examples of how teachers discriminate
Discuss
What can women or girls do to overcome bias and succeed?

II. Case Study Activity
How would you respond to this situation?

III. BREAK

IV. Evaluate Teaching Materials
Can you find any gender inequities or equities?

V. Video Part II: *Failing in Fairness* Dateline NBC 1998
(Diane Sawyer with Myra and David Sadker)

VI. Gender equity awareness assessment

Figure 1. Workshop Agendas for Gender Equity In Math, Science and Technology Classrooms

and engaged more females in science. The instructor group knew that the research aspect of the workshop was important and continually guided their own practice as teachers; therefore, relevant gender equity research findings were infused into the workshop through a pre-assessment (Figure 2).

The pre-assessment had three purposes: (1) reveal important gender equity research findings that describe the current state of affairs in science classrooms; (2) stimulate participants to think about their own practice as it relates to gender equity; (3) provide a framework to draw the participants into a discussion about gender equity research and their own classroom experiences. *Research Matters – to the Science Teacher* is a web-based publication from the National Association for Research in Science Teaching that includes teacher-friendly publications written by authors who publish additional technical papers in the *Journal of Research in Science Teaching*. Works from Baker[8] and Kahle[9] provided short summaries of the current literature and applied them to classroom teaching. From these publications an assessment was created to not only determine what the workshop participants knew about gender equity issues, but also to bring to their attention research findings that paint a realistic picture of what challenges girls in learning science and mathematics. It also furnished a framework for the discussion of a very broad and complex body of research. The participants responded to the 10 items in the pre-assessment by choosing either strongly agree (SA), agree (A), no opinion (N), disagree (D), or strongly disagree (SD). Some of the items were restatements of well-supported findings from the research, such as "Dualistic and hierarchical ideas in science, math, engineering, and technology are gender-neutral[8]." Other items were more personalized and related to their own teaching practices, such as "I devote equal time to male and female students."

The teachers worked individually without any discussion and spent approximately 10 minutes on the pre-assessment. The instructors then facilitated a discussion of the items, emphasizing when the item related to a well-supported research finding. The instructors provided details and examples to clarify each finding, and the teachers supported the statements with examples from their own classrooms. The more personalized items enabled the participants and facilitators to admit that addressing gender equity issues is extremely difficult; teachers are constantly raising their level of awareness and making continual changes in the way they teach. It was clearly stated that the instructors as facilitators were not perfect and were working to improve their own teaching. Specifically, in an attempt to get the participants attention, one facilitator said, "You guys. May I have your attention up here?" She immediately said, "See, I'm really trying to work on that."

Although the Gender Equity Assessment was not designed to measure changes in attitudes and beliefs about classroom gender equity issues, it was useful to examine the teachers' responses. All of teachers that took the post-assessment (N = 10) responded *yes* to item 11, indicating that they envisioned changes in the way they teach as a result of this workshop. They went on to list specific modifications in their teaching that included calling on girls as frequently as boys, asking more follow-up questions of girls, using more female role models and career emphases, and not pitting boys against girls.

Gender Equity Assessment

Please circle one response to each statement.

SA = Strongly Agree A = Agree N = No opinion D = Disagree SD = Strongly Disagree

1.	Equity and equality are synonymous.	SA	A	N	D	SD
2.	I connect educational factors to the under representation of women in science, math, engineering, and technology.	SA	A	N	D	SD
3.	Interventions to promote achievement and participation of female students is a form of reverse discrimination.	SA	A	N	D	SD
4.	Helping people, animals, and the world are values embedded in most science, math, engineering and technology curricula.	SA	A	N	D	SD
5.	Decontextualized multiple-choice questions are fair for boys and girls.	SA	A	N	D	SD
6.	Female teachers typically give more attention to female students.	SA	A	N	D	SD
7.	I devote equal time to male and female students.	SA	A	N	D	SD
8.	Dualistic and hierarchical ideas in science, math, engineering, and technology are gender-neutral.	SA	A	N	D	SD
9.	Boys and girls respond differently to highly structured, teacher-controlled classrooms.	SA	A	N	D	SD
10.	Teaching styles neither encourage nor discourage girls to continue in science, math, engineering, and technology courses and careers.	SA	A	N	D	SD
11.	Do you envision any changes in the way you teach as a result of this workshop?	Yes		No		
12.	If you answered "yes," please describe how you plan to change your classroom environment, curriculum, and/or instruction as a result of this workshop.					

Figure2. Gender Equity Awareness Assessment given pre and post workshop. Q11 & 12 were asked post only

A comparison between pre- and post-assessment responses ($N = 9$) did show that as a result of the workshop, more teachers disagreed with the following statements:

> *Decontextualized multiple-choice questions are fair for boys and girls.*
> *Equality and equity are synonymous.*

In the future, it may be useful to design an assessment to measure changes in attitudes and beliefs about gender equity classroom issues. It could address the degree to which teachers would implement the recommended strategies to improve gender equity in the classroom.

VI. Dateline Video Parts I and II

An integral part of the gender equity workshop consisted of viewing the Dateline NBC video: *Failing in Fairness* Parts I and II. Originally broadcast as two segments on Dateline: Part I aired April 7, 1992 and Part II aired Feb 8, 1994. *Failing in Fairness* is an examination of gender bias in American schools. The findings from twenty years of research by two social scientists, Myra and David Sadker, show that gender bias in our schools presents a challenge in providing an equitable education for boys and girls. Girls are consistently given less attention and encouragement than boys, especially in math and science, and they often fail to reach their potential. Part I was shown during the first workshop session in order to emphasize the importance and magnitude of the gender issues in the classroom. Part II, shown during session two, depicts innovative teaching methods designed to give girls an equal opportunity to succeed. Both parts contain interviews with gender bias experts Myra and David Sadker. The workshop participants responded to the video segments with some sense of surprise and disbelief, but mostly they all felt that the video was a great example of how gender discrimination is present in the classroom. They were surprised by the subtle discriminatory practices of teaching that create an inequitable classroom. They all agreed that the video demonstrated that gender discrimination in the classroom is still a challenge even for the well-intentioned most teachers.

VII.Classroom Strategies

The instruction team thought that it was important for the teacher participants to leave the workshop with information that they can apply and use in their classroom. A handout of classroom strategies was compiled and distributed to the participants. The team compiled this handout from several research sources, which provided specific suggestions for achieving gender equity in the classroom. This handout provided the participants with not only a description of the gender inequity issue, but also some possible ways to address it in their classroom (Appendix A). The list was not inclusive, yet it included strategies that could be incorporated in classroom interactions, teacher behavior, curriculum, instruction, and in general. The team found it interesting though that through the discussions, teacher experiences were shared and new strategies emerged.

VIII. Comic Strip Activity Parts I and II

The comic strip activity was integrated in the two workshop sessions to provide some comic relief while reinforcing the importance of respecting gender differences in communication.

Wiley Toons publishes a Non Sequitur comic strip series entitled, *Why We'll Never Understand Each Other*. These comic strips address commonly misunderstood statements and situations between men and women. They are typically written in two frames, with one frame entitled "What she heard…" and the other frame entitled "What he said…" As the last activity of the first session, participants were given one frame of a comic strip and were instructed to generate the other frame as homework. At the start of the second session, the participants shared their comic strips and compared them to the correct frame match. This activity was fun, thought provoking, and proved to be more than just an icebreaker activity. It sparked a fun and light-hearted discussion on other examples of miscommunication between men and women. The participants enjoyed this activity and many requested additional information on the comic strip

IX. Case Study

The case study activity was designed to allow teachers to critically examine a classroom situation, consider issues of gender equity, and reflect upon how this applies to their own practice. The participants read Wikel's 4-page chapter entitled "'Girlspeak' and Boyspeak': Gender Differences in Classroom Discussion" from *Gender Tales* [10]. The case involved a male teacher who invited a researcher into his classroom to examine the discussion dynamics and the seemingly different way boys and girls participated in his social studies classroom. The two main points of the case were that the teacher spent more time talking to the boys and that the boys and girls discussed the course content in very different ways. The boys talked directly to the teacher and the girls used "collaborative talk" in which they worked together to construct an idea.

The participants were placed into five groups of three and given a unique analysis question from the "Questions to Consider" that followed each chapter in *Gender Tales.* Each group spent approximately 20 minutes reading the case study, studying the analysis question, writing their individual responses on the handout, taking turns reporting their responses to their group, and synthesizing their responses into a succinct group response. A spokesperson from each group shared the answers to their analysis question.

X. Evaluate Teaching Materials

The participants evaluated resources and textbooks for seven forms of bias in instructional materials [11,12]. They were given examples of Invisibility, Stereotyping, Imbalance, Unreality, Fragmentation, Linguistic Bias, and "Cosmetic" Bias. They were asked to identify the forms of bias in several math and science instructional materials (Appendix B).

During the activity, teachers laughed in surprise, talked to their partner, or called us over to share their findings. One teacher with over 15 years experience said she expected to see images of male scientists in the older texts, but was surprised to find a girl squeezing a boy's muscle in a photograph from an elementary health unit in a recent publication.
Some groups focused on Invisibility Bias, by counting and comparing the number of men and women represented overall. Others focused on addressing the specific questions on the handout (Appendix C). Teachers were surprised to find the prevalence of "Cosmetic" Bias and although they had often seen it, they had never noticed. For example, elementary science texts often

picture children doing something on the lab experiment pages. In one particular book, published within the past five years, one group found that there were more boys that were pictured as actively doing something, while the female was pictured along side a boy as a "prop," usually watching the boy.

Based on the questionnaires, the instruction team was aware of the teachers' requests for applicable strategies. Because some of the teachers were responsible for text selection at their school, the instructors felt this activity was a concrete example of inequities in math and science that they would remember and could apply in future text selections.

XI. Participant Evaluations and Discussion

After each of the WISE workshops, the teachers were asked to provide feedback Focus groups with the teachers were conducted by an external reviewer and the instructors were not present. Several weeks later, the instructors were provided with the comments from both sessions. Comments in Table 1 were positive and teachers included the specific activity they liked best. Although there was not one preferred activity, each one conducted (discussion, video, text analysis, comic strip) was favorably addressed by at least one teacher.

The instructors were pleased to see that the teachers enjoyed the workshop, and wanted to address their comments and concerns. (See Table 2: Participant Feedback.)

- *Very motivational/thought provoking, but where do you want to go with this topic?*

Based on our questionnaires, the instructors wanted to provide teachers with both a mix of background information (research) and concrete examples and resources. It was not their attempt to try to "solve" gender inequities in a two-session workshop, nor was it their attempt to inundate them with research. The purpose of the gender equity workshops was to heighten the teachers' awareness of gender issues that oftentimes get overlooked and to provide specific strategies that could be used in their classroom.

- *Discussion was vague in the sense of avoiding hitting the target on the head. How do we know when this situation in fixed?*

Due to the variety of activities planned and the limited time, the group discussion time of 45 minutes seemed to be too short for some participants. This response reflected an interest on the teachers' part, so the instructors interpreted this positively since teachers were leading the discussion and showing an active interest. Feedback indicating that discussion time was limited reflected that the participants were just beginning to scratch the surface of gender inequities and wanted to address the issue further.

General	**Video, Text** and **Comic Strip**
The women presenting this workshop were knowledgeable and presented the information in a "non-threatening" manner	Examples of bias published was a new angle I hadn't considered much before
Great session! I just had Dale's program two years ago but a refresher is always good.	I liked looking through the science books to look at the diverse or men-diverse scientist in the books.
An eye opener! Raised awareness and helpful in identifying behaviors	Loved the text analysis.
Interesting It refreshed my memory. I did have gender equity training in the masters' ed. program at ASU, but had not thought about it for years. At one time I was paying attention to gender issues but had stopped.	I would like to have access to the comic strips.
Helped me to remember that we must always try to give equal time to both sexes.	Loved the cartoons
I thought the session was informative.	Great video examples
Raised awareness and helpful in identifying behaviors	Video-good. This would be the time to present subtle discriminations.
Just as good as the first session! I truly feel that this was the most important session because it dealt directly with relationships with children. Building relationships and making connections are vital to increasing academic achievement!	Failing at fairness segment-great!
I learned lots of things to look for in my classroom. This session has made me much more aware of my student's needs and how to address them equally (as much as possible). Handouts are great to share with other teachers at my school.	I enjoyed the 20/20 video
I thoroughly enjoyed this. The film, activity and materials were excellent.	I enjoyed the videos.
The session was very informative. It was well put together.	Fantastic film segment on failure at fairness
Great session-Nice refresher	I enjoyed the dateline video.
Great follow up	

Discussion
Discussion-very good I enjoyed the discussion Excellent discussion. The speakers were extremely attentive to our discussion. I enjoyed the reading.

Table I: Positive comme nts received after each session.

General	Video
Very motivational/thought provoking, but where do you want to go with this topic? A folder (pocket) to be able to keep all materials together for each session Thanks for the awareness ...but at some point it almost sounded like reverse discrimination. This segment left me with the question of whether women do wish to be treated equally instead of equitably.	Interesting video from dateline. I went to an all girls' school and can definitely see a difference in classroom climate when you have a co-ed class versus all girls. I don't think it's a teacher issue.

Discussion
Discussion was vague in the sense of avoiding hitting the target on the head. How do we know when this situation in fixed? What did the presenters view as ideal? Longer discussion time (Especially when the group has a lot to discuss) per session. Time constraints limit discussion opportunity

Table II: Participant feedback that addresses questions, comments or concerns

Solving or fixing gender inequities was not the focus of this workshop. Creating an equitable classroom environment is a process rather than an end product that cannot change overnight. These issues are embedded in the curriculum and traditionally reflect the cultural practices of teaching Western white male science. The instructors wanted teachers to become aware of the challenges that female students face in science education. Although these issues will not be "fixed" immediately, an attempt to swing the pendulum in a more equitable direction is the goal.

- *What did the presenters view as ideal?*

The instructors purposely avoided defining what they thought was an "ideal" classroom situation. However it was emphasized that a teacher who is aware of his/her own biases can begin to change their own teaching practices in an attempt to create more equitable math and science classroom.

In addition, teachers has their own conception of "ideal" since teachers differ in their approach and goals for teaching science (i.e. science for encouraging future scientists, developing analytical and problem solving skills, creating aware citizens, etc.). A teacher who is interested in promoting science for future scientists may address scientific milestones in relation to male and female scientists, while a teacher interested in promoting responsible citizens may tap into both male and female interests such as the effects of a chemical waste plant on the environment. How a teacher views science will impact how they attempt to create a more equitable classroom and curriculum.

- *I don't think it's a teacher issue.*

The instructors would agree to the above statement if it read, "I don't think it's only a teacher issue." While gender and cultural inequities remain a societal issue, attempts to change these views can begin in the classroom. Realities that a child may experience outside of the classroom do not need to be reinforced in school. The instructors and the entire WISE Investments staff hope that by heightening teacher awareness of gender inequities, it begins to trickle down into their students' perceptions of societal barriers and traditionally male-dominated fields of study, and in turn will promote tolerance, diversity and equity, and provide equitable access to science content, knowing, and process.

XII. Conclusion and Recommendations

After four years of "presenting" gender equity material to middle school teachers and counselors, it seems that we finally got it right. A major change in the approach included having the instructors acknowledging that they were not experts and were learning right along with the WI participants. The research background on gender equity was presented indirectly through an assessment tool. This manner of delivery was accepted much better than the direct delivery techniques of the first three gender equity workshops. These instructors added several fun, interesting, hands-on activities for the teachers that reinforced what was being taught. The teachers were also able to observe biased behavior in the classroom and then classroom dynamics that supported gender equity. Although some teachers were disappointed that there

was not an "ideal" classroom for which to strive, the most encouraging complaint was that they needed more time on this subject. The funding for WISE Investments is now at an end and there are no plans to continue the project. If we were called upon again in the future to do gender equity workshops, we would use the workshops just described as the model and add a little more time for the participants to explore the subject more thoroughly.

References

1. Blaisdell, S, Anderson-Rowland, M. R., White, M. A., Mowzoon, M., "WISE INVESTMENTS": A Yearlong Pilot Program Introducing Engineering to Teachers and Counselors," Proceedings American Society for Engineering Education, Charlotte, North Carolina, June 1999, Session 1392, CD-ROM, 6 pages.
2. Castro, M., Blaisdell, S. Moore, M., Anderson-Rowland, M. R., "University Faculty Commitment and Involvement in an Outreach Program: Instrumental in Program Success," Proceedings, American Society for Engineering Education, 2000, St. Louis, Missouri, June 2000, Session 3592, CD-ROM, 9 pages.
3. Secola, P. M., Smiley, B. A,. Anderson-Rowland, M. R., Castro, M., Tomaszewski, B., "Assessing the Effectiveness of Saturday Academies in an Engineering Outreach Program," Frontiers in Education '01 Conference Proceedings, Reno, Nevada, October 2001, CD Rom, Session S1F, pp. S1F-16 – S1F-21.
4. Castro M., Smiley, b. A., Secola, P. M., Anderson-Rowland, M. R., "Making the Engineering Connection: Industry internships for Pre-College Educators," WEPAN 2002 Conference Proceedings, San Juan, Puerto Rico, June 2002, Paper 7018, 5 pages.
5. Sax, L.J., Lindholm, J. A., Astin, A. W., Korn, W. S., Mahoney, K. M. *The American Freshman: National Norms for Fall 2001.* Los Angeles: Higher Education Research Institute, UCLA, 2001.
6. Secola, P. M., Smiley, B. A., Anderson-Rowland, M. R. "Assessing Attitudinal Change in an Engineering Teacher Professional Development Program," NAMEPA/WEPAN 2001 Conference Proceedings, Alexandria, VA, April 2001, pp.154-158.
7. Secola, P. M., Smiley, B. A., Anderson-Rowland, M. R., Baker, D. R., "Evaluation the Effectiveness of Gender Equity Training in Engineering Summer Workshops with Pre-College Teachers and Counselors," with Secola, Smiley, and Baker, 2001 Proceedings of American Society for Engineering Education Annual Conference, Albuquerque, New Mexico, June 2001, CD Rom, Session 1692, 14 pages.
8. Baker, D.R., *Teaching for Gender Difference*, Research Matters – to the Science Teacher, National Association for Research in Science Teaching. http://www.educ.sfu.ca/narstsite/research/gender.html
9. Kahle, J.B., *Encouraging Girls in Science Courses and Careers,* Research Matters – to the Science Teacher, National Association for Research in Science Teaching., 1995. http://www.educ.sfu.ca/narstsite/research/encourage.html
10. Kleinfeld and Yerian, eds., *Gender Tales: Tensions in the Schools*, 1995.
11. Sadker, M. P., Sadker, D. M., *Sex Equity Handbook for Schools.* New York: Longman, Inc., 1982, pp. 72-73.
12. Sadker, M. P., Sadker, D. M., *Gender Bias in the Curriculum.* Washington, DC: National Education Association, 1995, p. 11.

Biographies

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Mary R. Anderson-Rowland is the Associate Dean of Student Affairs in the CEAS at ASU. She earned her Ph.D. from the University of Iowa. Her research areas are in applied statistics and engineering recruitment and retention, especially for women and minority students. She was named an ASEE Fellow in 2001and the Society of Women Engineer's Distinguished Engineering Educator for 2002. She received the University Achievement in Gender Equity Progress Award in 1995. She is the PI of the NSF grant supporting the work of this paper.

Appendix A

Strategies to Avoid Bias and Promote Gender Equity in the Classroom

In General...

- Observe classroom dynamics.
- Shift from a competitive to a cooperative educational model.
- Make the curriculum and activities relevant to students' lives.
- Fight narrow stereotypes of science.
- Provide diverse role models.
- Foster self-confidence.

Classroom Interactions/Environment/Teacher Behavior

Teaching with gender equity implies everyone in the classroom and the teacher must critically examine their own behavior and assumptions to create a learning environment that supports and encourages learning for all students.

- Alternate questioning between males and females.
- Recall that assertive students are not necessarily more capable than less assertive students.
- Be alert to teasing. It discourages participation by female students.
- Encourage ALL students equally.
- Especially monitor achievement of female students on a regular basis.
- Generally, girls, unlike boys, avoid tasks labeled difficult and don't return to difficult tasks if they experience failure.
- Monitor your own use of sex-biased language.
- Have high science expectations for all students. Positive expectations tend to increase student achievement.
- Learn as much about female students as males.
- Especially, inform female students aware that most jobs in the future will require strong math, computer, and science skills.
- While encouragement from both female and male teachers is a major factor in students persisting in science, it is especially important for girls to have access to encouragement from female role models.
- Present science as a subject that everyone can learn. Teachers who emphasize the difficulty of science also create a negative learning climate for girls.
- Recognize effort as well as accomplishment, especially for female students.
- Give both boys and girls equal feedback.
- Involve those female students who are not participating in science classroom discussions.
- Make an equal effort to check science classroom work for all students.
- Notice and respond when girls raise their hands. Generally, disregard boys' greater tendency to verbally and non-verbally demand greater teacher attention. Devise a specific response selection protocol and consistently use it.
- Use the same nonverbal cue to address both boys and girls (e.g., head nodding and encouraging smiles).

Curriculum

- Give girls early and continuing exposure to hands-on science.
- Include female role models when presenting science achievements.
- Allow students to select topics in some science study units. (This offers additional opportunities for students to relate their backgrounds and interests to science.)
- Have activities which stress thought processes rather than exclusive reliance on single answer responses.
- Use real-life metaphors and examples in teaching that are pertinent to female students. (Female metaphors should be balanced with ma le ones.)

- Permit students to bring life experiences into the science-learning environment. (All students, especially female students, tend to perform best when content is related to previous experience.)
- Present science as a subject that everyone can learn rather than as an elite and difficult subject.
- Try to schedule science courses so they do not conflict with electives that may be especially appealing to female students.
- Focus on activities designed to integrate science skills into the everyday experiences of female students.
- Encourage all students to apply science classroom learning to practical and everyday situations. (Give examples).
- Make science relevant and useful to all students, but especially to female students.
- Provide opportunities for students to learn about the requirements and descriptions of jobs that apply mathematical and scientific knowledge.

Instruction

- Give girls early and continuing exposure to cooperative problem-solving.
- **Shift from a competitive to a cooperative model.**
- Make task assignments at random or use a list of students' names and check them off after you ask a question.
- Offer help to any and all students when the material is difficult. Suggest after school help for everyone.
- Encourage activity-based and hands-on programs for all students.
- Many students learn principles of science easier through discussion and exploration rather than by traditional lectures.
- When using group activities, such as lab work, assign each student a specific role. Keep a record of these roles and rotate students through the different roles.
- Encourage group studying that provides students with good study habits and fosters good academic achievements.
- Assign each student with an experienced mentor in to advise him/her about career choices, individual research and possible solutions.
- Monitor achievement, on a regular basis, including participation in classroom discussions, experiments, etc., of all students.
- Consider using upper grade-level female students as tutors in computer-related activities and in science techniques.
- Motivate your students to solve a problem for the fun of it or the satisfaction of getting a right answer.

The strategies were compiled from gender equity web sites at West Virginia University and Brown University. For more information, please visit these sites.

http://www.as.wvu.edu/~equity/gender.html

http://www.brown.edu/Administration/Dean_of_the_College/homepginfo/equity/Equity_handbook.html

Appendix B

THE FORMS OF BIAS IN INSTRUCTIONAL MATERIALS

INVISIBILITY	Certain groups are underrepresented in curricular materials. The significant omission of women and minority groups implies that they are of less value, importance, and significance in our society.
STEREOTYPING	By assigning traditional and rigid roles or attributes to a group, instructional materials limit the abilities and potential of that group. Stereotyping denies students a knowledge of the diversity, complexity, and variation of any group of individuals. Children who see themselves portrayed only in stereotypic ways may internalize these stereotypes and fail to develop their own unique abilities, interests, and full potential.
IMBALANCE	Some texts perpetuate bias by presenting only one interpretation of an issue, situation, or group of people. This selectivity restricts students' knowledge of the varied perspectives that actually apply, thus ignoring differing viewpoints, reducing complexity to a simplistic level, and distorting reality.
UNREALITY	Some texts present an unrealistic portrayal of our history and our contemporary life experiences. Controversial topics are glossed over and discussion of uncomfortable realities, such as discrimination, bias and prejudice, are avoided. This incomplete or unrealistic coverage denies children the information they need to recognize, understand, and perhaps some day conquer the problems that plague our society.
FRAGMENTATION	By isolating issues related to women and minorities from the main body of the text in sidebars or boxes, instructional materials imply that these issues are less important than and separate from the rest of the topics and the cultural mainstream.
LINGUISTIC BIAS	Curricular materials reflect the biased nature of our language. Masculine terms and pronouns, such as the term forefathers or the generic he, deny the participation of women in our society. Occupations such as fireman are given masculine labels that deny the legitimacy of women working in these fields. Imbalance of word order and lack of parallel terms that refer to females and males are also forms of linguistic bias.
"COSMETIC" BIAS	Textbook layouts can falsely suggest that women and minorities are included equally throughout the text, perhaps by prominently displaying pictures and highlighted sections featuring their experiences and accomplishments, while a careful analysis of the six factors above shows that these groups actually receive little coverage. This is especially an issue with more recent materials.

Adapted by permission from: Sadker, Myra P. and Sadker, David M. *1982). Sex equity handbook for schools.* New York: Longman Inc., pp. 72-73. Also Sadker, Myra and Sadker, David *(1995). Gender bias in the curriculum.* Washington, DC: National Education Association. p. 11.

Appendix C

Assessing Classroom Materials Activity

You will be looking at and analyzing some classroom math and science materials. As you flip through these, ask yourself the following questions:

1. How many men and how many women are pictured?

2. How are they described?

3. What are these people doing?

4. Do any of these images or words reveal **sex-role stereotypes**?

5. What other forms of bias can you find? (See the back side of this sheet for a list and description of types of bias). Sticky-note these pages and be prepared to share with the other groups.

a. Invisibility

b. Imbalance

c. Unreality

d. Fragmentation

e. Linguistic Bias

f. "Cosmetic" Bias

Sanders, J, Koch, J., Urso, J. (1997). Gender Equity Sources and Resources for Education Students. NJ: Lawrence Erlbaum Associates.