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Teaching discourses: Science teachers' responses to the voices of adolescent girls

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TEACHING DISCOURSES: SCIENCE TEACHERS' RESPONSES TO THE VOICES OF ADOLESCENT GIRLS

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ABSTRACT. The purpose of this study was to provide an opportunity for science teachers to 'listen' to adolescent girls discuss their ideas and feelings about the contemporary structure of middle-level science education. The reflections of these teachers were then analyzed to capture how the teachers interpreted what adolescent girls had to say and the action that they will take in the classroom as a result of those interpretations. This qualitative study investigated 11 teachers and 51 Grade 7 and 8 girls from various states across the continental USA. The girls discussed such things as their favorite science topics, comfort level in science classrooms, and curiosities about the physical world. The study revealed that adolescent girls strive to make a connection to science. They can see how science can help them to understand better themselves and their world, but they seldom find such understandings in contemporary science classrooms. In addition, adolescent girls not only need to have choices in their studies, but they understand that need. The study revealed that the teachers interpreted the girls' request from an assimilative perspective by seeking ways to help the girls 'fit' into the existing structure of science education. The implications of the study suggest that science education will need to change in response to the voices of the 'others', but that change will only happen if we prepare teachers better to be prepared to listen and change practice in light of what they hear.

KEY WORDS: adolescence, gender issues, qualitative research, science education, students' voices, teaching discourses

Over the past decade, many authors have begun to challenge the sociocultural ideologies and practices of science. They have provided a strong rationale for opening the science discourse to allow for the voices of the 'others' — those that have been historically silenced by the scientific establishment.

There are progressive and regressive tendencies in contemporary Western science. Some of the regressive tendencies include an overemphasis on being dispassionate and disinterested. This overemphasis on *one* way of viewing the world affects the way in which we have learned to understand our world (Harding, 1991). Harding points out that:

> Whoever gets to define what counts as a scientific problem also gets a powerful role in shaping the picture of the world that results from scientific research. . . what gets to count as a problem is linked with the purpose for which the research is done — or at least for what is funded, (pp. 40-41)

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Our picture of the world and ourselves can become more holistic as we learn to include a look at it from the view of others. Harding points out that women can provide a different way of understanding the world. Women's contributions — not just those few extraordinary female individuals who are spotlighted in textbooks — need to be included in science. These contributions must come from the voices of these women, not just the presence of the female sex; that is, they must be allowed to speak with their own voices.

Authors such as Harding (1991), Atwater, Crockett, and Kilpatrick (1997), and Mayberry (1998) suggest that science will never truly be impacted by the voices of 'others' if we continue to foster only the White, Western, masculine voice in the science classrooms. When referring to voices, it is important to note that these individuals are referring to more than words. They are referring to an individual's point of view or understanding of reality (Belenky, Clinchy, Goldberger & Tarule, 1997). Our developing ideas of 'voice' and the implications on education are based on the contemporary work being completed in the area of adolescent moral development, such as the new understandings of the development of adolescent girls resulting from the work of Carol Gilligan. Gilligan (1988) compares the 'exit-voice' option of boys with that of girls. By exit-voice option, she refers to a choice between leaving a situation that is not acceptable (exit) or choosing to protest or disagree (voice). Once boys reach an age when they begin to develop a sense of independence and identify 'exit' as an option, their voice gets stronger. If they cannot change a situation, they know they can leave, thus becoming more independent. However, when girls reach that same point, they connect the option of 'exit' with being excluded from relationships. For these girls, 'exit' is not an option; if voice does not work, it is a threat. If they do not accept a situation, they could be forced to leave and become more isolated. These girls would rather change or silence their own voice in order to sustain relationships. The hidden curriculum often supports the adolescent girls in silencing their own voice by concentrating on teaching girls how to 'fit' themselves into a silencing structure.

Maher and Tetreault (1994) argue that classrooms are environments in which students develop their voices rather than find them. As a result, the female voice is especially vulnerable in the middle-level classroom. Brown and Gilligan (1991) found that, at this age, girls often suppress the depth and breadth of their knowledge base. Often, they resort to speaking in a 'fraudulent voice' rather than risk being isolated. It is within these critical years that the girls' identities become lost within the dominant structure.

It is in these years that the girls are in danger of disappearing (Gilligan, Lyons & Hanmer, 1990).

This study is based on the philosophy that changing science education must involve more than the introduction of a new curriculum or the addition of assimilative teaching methodologies — true change will require fostering an environment in which girls are given the opportunity to try out and foster their own identity within the world of science. Otherwise, girls' voices will be lost. In order to achieve such an environment and in order to foster voice, teachers must be able to respond. Creating an environment that fosters the girls' efforts to develop voice means more than allowing them to speak while still responding solely to the dominant voices. Giving adolescent girls a voice in the middle-level classroom means including them in the conversation.

This study looks at the discourse between adolescent girls and middle-school teachers in a holistic manner. The dialogue is monitored from adolescent voice to teacher response (classroom action). The guiding questions of the study are sequential. The first question (What do the girls have to say?) focuses on identifying what the girls tell the teacher they need. The second question (What do the teachers hear?) focuses on the teachers9 reflections of what the girls told them. The third question (What will the teacher do?) focuses on the teachers' responses by means of classroom actions that will occur.

1. Approaches to Gender Studies in Middle-Level Science

Researchers can approach multicultural and gender issues from vastly different perspectives. Therefore, it is imperative that a researcher is fully aware of the underlying philosophical approach guiding a study on such issues. Willis (1996) has developed a framework that will be utilized better to view these different perspectives, as well as to establish the approach to this study.

Willis identified four broad perspectives of the mathematics curriculum in regard to disadvantaged youth and social justice. One perspective views the student as 'deficit'. That is, youth are disadvantaged in that they lack the necessary skills or understandings needed to reach the curriculum goals. The solution is sought by providing these children with what they lack. Jovanovic and King (1998) developed a gender in science education study from this perspective. Their study was developed as a response to the fact that adolescent girls lack the exposure to science-related activities outside school. These activities include tinkering with mechanical objects, science

clubs, etc. They felt that, by utilizing performance-based teaching, "the science classroom will become an equalizer by compensating for the disparities between boys' and girls' experiences. ..." (Jovanovic & King, 1998, p. 478). These authors saw a deficit; therefore, their solution was aimed at eliminating that deficit. In their study, these researchers did not find support for the expectation that performance-based classrooms would help to "compensate for the disparities in boys' and girls' experiences... ." (p. 490). One possible suggestion for the findings was the fact that the "boys tended to hog the resources" (p. 491). This suggests that, as a result of their research experience, these authors can now be approaching gender issues in science education from the second perspective.

A second perspective views the pedagogy or assessment procedures as more advantageous to certain groups of children. Those that perceive educational problems from this 'non-discriminatory' perspective seek to eliminate those strategies that could be more advantageous to one group (e.g. hands-on activities that allow the boys to handle the equipment more than girls). There is an extensive list of authors that approach gender projects from this perspective (Jones & Wheatley, 1990; Kahle & Lakes, 1983; Tobin, Kahle & Fraser, 1990). Another example is Meece and Jones (1996) who take this perspective when they suggest: "It is possible that the masculine image of science has a more favorable influence on low-ability boys than on their female peers" (p. 410). These authors are viewing certain aspects of science education that are more advantageous to adolescent boys than adolescent girls. Therefore, their approaches focus on eliminating the biased procedure.

A third perspective, thatWillis (1996) identifies as 'critical', is seeking an education that strives to achieve social justice. Those that perceive traditional science as playing a major role in maintaining the dominant culture's values and interests seek to disrupt the position and privilege that one culture has over another. This is accomplished, first, by enlightening students about the position which they and others are often held by science and, second, by exploring what they can do to achieve social justice (p. 48). Alberto Rodriguez (1998a) urges all members of the educational research community to "interrogate, or continue to interrogate, the positions of privilege inherent in the work we do" (p. 965). His own research reflects this perspective (Rodriguez, 1998b). In addition, Gwyneth Hughs (2000) takes such an approach. She suggests that teachers "become more aware of their complicity in both marginalizing socioscientific material and perpetuating gender essentialism" (p. 438). She concludes that ". . . an understanding of gendered science, and a commitment to improving

inclusivity through challenging masculine hierarchical approaches to science, are fundamental to curriculum reform that aims to turn science for all from rhetoric without conviction toward a closer description of a reality" (p. 438). These authors see the need to address issues of social justice within the science classroom.

A fourth perspective, 'inclusive', seeks to broaden the curriculum and pedagogical practices to be more reflective of different social groups' experiences, interests, and needs. Gaskell, Hepbum, and Robeck (1998) designed their gender equity project from this perspective. These authors developed and utilized: (1) an electricity module in which ideas were embedded that are typically associated with both men and women, while recognizing the diversity of ideas and interests found within these two groups; (2) an assessment unit that contained items for the use of student knowledge of electricity in relation to social problems; and (3) a pedagogy in which gender relations in the classroom were explicitly discussed (p. 860). These authors, as well as a growing number of their colleagues, believe that science classrooms are structured around the voices of the dominant group, silencing the voices of others. Therefore, their approach focuses on including the ideas, interests, and needs of others into the science classroom.

This article is presented from the inclusive perspective. This research was completed with the understanding that the classroom environment needs to become more inclusive of the experiences, interests, and needs of women. Inclusion is used in the respect that the voices of the 'others9 should be included in the science classroom, but it is not intended to establish classrooms in which any one of these voices becomes 'the' next voice to be overemphasized. It is my philosophical understanding that a more inclusive science education is needed, if a more inclusive science is ever to be achieved.

2. Methodology

2.1. *Participants*

Fifty-eight middle-school female students participated in this study. Of the students, 51 were in Grade 7 or 8, five were from Grade 6, and two were from Grade 9. For analysis purposes, only those girls from Grade 7 or 8 were analyzed. Parental consent was obtained before the girls participated in the interviews. The majority of the girls were White females from lower- and middle-class communities.

Eleven middle-level science teachers participated in the study. Of the teachers, seven were female and four were male. Four of the teachers had one—five years of teaching experience, four teachers had six—ten years of teaching experience, two teachers had 11—15 years of teaching experience, and one teacher had greater than 20 years of teaching experience. The teachers represented schools located in various states across the continental USA, including Florida, Tennessee, Michigan, Nebraska, New Jersey, and Ohio.

The teachers were recruited at a national conference. They attended a conference session titled, 'Giving Girls a Voice in Science Education: A Research Opportunity'. At that session, the parameters of the study and methodology were explained. Participants also took part in a trial focus group interview, practicing the strategies of group facilitator. All facilitators received a packet that included permission forms, interview questions, a review of facilitator strategies, tape, and return envelopes and postage. Tape recorders were also available. Following the initial training session, teacher participants were contacted on several occasions by email or phone. Of the participants who took part in that initial session, seven completed the entire process. Four other teachers were recruited and the process was reviewed. Additional recruits were found by making contacts at various schools around the country to identify middle-school teachers who would be interested in taking part in the project. Prospective recruits were then delivered or mailed (depending on distance) a packet of information that explained the project.

For their participation, all participating teachers received a stipend. A decision to offer this stipend was made in light of the amount of administrative paperwork that was added to the process so that the results could be disseminated. However, this stipend was not mentioned until after the teachers expressed an interest in participating. Inquiries into the reason for nonparticipation on the part of some participants revealed that the amount of time required for these administrative details (school permission, parent permission, etc.) was the greatest impediment to participation.

2.2. *Interview Procedure*

Each of 11 teachers conducted one 45—60-minute interview. One teacher elected to conduct two interviews, one with four of her Grade 7 girls and one with four of her Grade 8 girls. A focus group interview structure was utilized in order to attempt to limit the parts of the traditional interview that emphasized the "powerful voice and the researcher" (Wilkinson, 1999, p. 66). In the interviews utilized in this study, the girls were not put into a position in which they were singularly speaking to a person in authority;

they were not acting in isolation. They were members of a peer group. However, in order to assure that all groups focused on specific areas of science education, a standard focus group format was followed, thus limiting some of the freedom of the group. The facilitator followed a semi-structured interview guide consisting of discussion questions. The teacher-facilitators were instructed, as well as provided with a guide sheet, on how to use the questions as guides for conversation.

The questions solicited the girls' previous experiences with science (in and out of school), their worries about the science classroom, favorite science topics, and suggestions/advice for science curriculum developers. The procedure included asking a general question of the group, soliciting input, and probing with more specific questions until all relevant views had been expressed.

Each interview group consisted of the teacher/facilitator and four—six girls. All interviews took place at the teacher/host site outside the normal science course structure. The teacher/facilitator explained that he/she was conducting an interview for a professor who is interested in what they like about science education, their concerns about the subject, and their scientific interests. All interviews were audiotaped and the tapes were sent back to the researcher, along with the administrative documentation.

2.3. *Written Documentation*

The participating teachers wrote and submitted a reaction paper about their experience with the adolescent girls. This response sheet was requested and explained at the initial training session, as well as in the written instruction sheets provided for the teachers. In this response, the teachers were asked to include a description of what they heard the girls say, their reaction to it, and the impact that their voices should have on their teaching practices and classroom curriculum. These written responses were sent back to the researcher along with the tapes and administrative documentation.

2.4. *Analysis*

The interview tapes were transcribed and the written responses were processed. The verbatim interviews and the teacher responses were read. Two separate initial categorization systems were developed after several readings of the documents. The basic codes for the girls' responses and teachers' description of what the girls said were desired understanding (What knowledge were they seeking?), choice, and desired classroom strategies

(What did they want to occur in the classroom and why?). Coding for the teachers' selected classroom responses included type of strategy, reason for choice, and frequency of occurrence. The verbatim interview transcriptions and written documents were then coded based on these systems. The systems were tested for completeness (Guba, 1978). The steps utilized in this study included: (1) checking for internal/external plausibility by checking for consistency within each category and reading through the category as a whole to see if it made sense, (2) checking for the inclusion of sufficient data to make a statement about the case, and (3) asking colleagues to read through statements and evidence to determine reproducibility.

The findings are presented in three sections. The first, what the girls said, describes the findings from the analysis of the focus group transcripts. The second, what the teachers said, describes the findings from the analysis of the written responses. The third, how the teachers will respond, describes the actions that the teachers felt needed to occur as a result of what they heard the girls say.

3. Findings

3.1. *What the Girls Said*

The verbatim transcripts of the focus groups' interviews were thoroughly read and the emerging themes were used to develop the coding system. The transcripts were then coded, categorized and checked for completeness. The analysis revealed the following:

3.1.1. *We Are Trying to 'Understand' Our World and Ourselves*

The girls expressed a genuine interest in and a desire truly to understand science as it relates to their world. However, often this was explicitly and implicitly contrasted with the push to 'know' science for the classroom. Overall, the girls did not understand why the science education program did not allow them to understand science in general, and why it did not allow for an understanding of the science that was part of their world.

A review of the transcripts revealed that the girls are interested in science. As they answered the questions, they would often break out in discussions on science topics from their everyday worlds. One student wondered: "Didn't they say that they found another planet or something?" Another wondered: "Like if you train a dog and wonder if it even remembers it?" Other girls were curious about science concepts that were related to the human body:

> Okay, well, I think that lately there's this issue about cancer—on a small island off Spain, scientists have found a way to cure cancer and they're testing it as we speak. It's from the poisons of squid and it... will kill cancer . . . And it's a very exciting thing, 'cause cancer has never had a definite cure.

Several groups of girls at one time or another discussed their concerns about the environment, with one discussion beginning as one girl wondered:

> . . . when I walk to school and you know it's cold in the morning? You know, you can see your breath? Well, you can see that smoke coming out of those pipes, and I don't know if that's like smoke that won't harm the environment, but you can see it behind the school and it looks kind of bad.

The list of questions about science topics that explained their world was extensive. However, the girls revealed that they seldom found the answers to these questions in their science classroom. Girls said that many of the topics in the classroom were "boring" and did not satisfy their longing to understand their world. One girl remarked: "Like chemistry, learning about those elements — how boring. Yeah! And how do they expect you to remember all those letters? I mean, who's going to go out into the world and say 'OK this is a chemical equation, let's figure it out.'" Another group mirrored that response: "Who's going to go out into the world and say, 'OK, that's a chalkboard, it's made out of iron ... their letters are F and E.' Who's going to actually do that?" Another girl described how frustrating it is to leam what the school feels is important while you're worried about real science issues. She cited one frustrating experience, similar to others that were shared, when her teacher started to tell them that deodorant can cause cancer, and then the teacher just stopped that topic and got back to the scheduled science lesson. "It's like if they tell you that you can get cancer, and then they shouldn't just stop and say forget that—it's like you can't forget it!"

The girls also worried about the fact that they did not believe that they were being supported in their efforts truly to understand science. One girl remarked:

> I think that kids are being like they'll just study the material like a lot of times from the book. We read a chapter, take a test, go to the next chapter and half the stuff I read in here I wouldn't be able to tell you . . . You have had all your life and you can't remember anything because it hasn't been taught.

Another complained that there was not enough time to understand anything: "There's too much information that she wants us to know." Another group began discussing this topic when one girl remarked:

... I mean that it kind of, it doesn't really make sense and also some things, like, they just teach us to know. But I think that, even though a lot of people use this stuff, some things nowadays we don't use. So I think that we should learn it in a later grade where it's more advanced, so that we can actually have more time to learn about the things that we use at our grade level.

This phenomenon worries the girls. As one put it, ". .. like, sometimes in science I'm worried that, like, I learned it for a test, but I don't really understand it."
She went on:

I guess for, like, the first five or six years in school . . . always just used to memorize until I realized that this is my life. If I don't start learning stuff, I'm going to be ... so like nothing. And that's when I started, like, knowing that school is important, and what you do now is going to affect what you do for the rest of your life. So that's why in science, and like science, is probably one of the most important classes you're going to take. Because it kind of tells you about the world around you. . . This is telling you how things work, and why things happen for a reason.

Another remarked about a science unit that: "I just didn't like it. I didn't really understand it."

The girls can see that science can help them to understand themselves and their world. But, they seldom are able to explore that connection in the existing structure of science education. They expressed a frustration with being in a classroom that pushes them to memorize pieces of information for a test, instead of helping them to answer their questions about their everyday world.

3.1.2. *Give Us a Choice*

If you tried to pull out 'the' topics to teach girls, topics that would be sure to pull them into the subject, it wouldn't work. Their interests and fascinations were very diverse. However, they didn't express the desire to study only their favorite topics, but to change the very act of having the topics chosen for them. They understood and expressed, both implicitly and explicitly, the need to be able to choose what to explore in the world of science.

The girls had very diverse interests in science. One girl likes learning about Earth science: "I liked learning about the 'Big Bang' and how everything got formed." However, another liked physical science because "with physical science, you have so many questions about how things happen and work". Still another found biology to be the most "intriguing". For each of these likes, there could also be found a girl who did express a disinterest in the subject. For example, someone didn't like Earth science

and another didn't like biology. Other interests that could be found in the discussions included x-rays, viruses, cells, weather, animals, stars, global warming, electricity, insects, and even fungus. Some girls expressed a desire to dissect something, while others found it "really gross" or "bloody". In addition, some girls wanted to leam about evolution, stating that "Charles Darwin worked really hard on the evolution theory, and I think we should, like, recognize his work, since he did prove his theory". Others ".. . didn't really feel comfortable around it".

In their groups, the girls were not surprised that they did not like the same things. Nor did they struggle about whether one should study fungus or not. They reasoned: "It's like elephants are boring, because I don't like them... But someone else did elephants and they liked them." They did not hesitate to declare that there are different interests and needs and that everyone should have some choice in what they study.

The girls also expressed that they enjoyed the activities for which they were given a choice of which science topic to explore. As the girls discussed their favorite lessons, they often referred to ones for which they had a choice. "(I liked) different projects where we got to choose what we wanted to do." "She liked what she was doing.. . she got to choose." "That was my favorite (unit) because we got to choose what we wanted." The girls made many statements that revealed that they felt that students should have choices in the classroom, and that "... you've (the teacher) got to bend a little.. .. We've got to have input in what we're going to be learning — what's going to affect our future."

The girls were not requesting that their teachers include specific topics that are of interest to girls; they were requesting that the teachers allow them to select topics that would interest them as individuals. They were requesting to be included in the very act of curriculum selection. The girls were requesting more power in the classroom.

3.1.3. *Help Us to Understand*

The finding in this category, dealing with how the girls felt that they learned best, further supported the girls' desire to search for understanding of those science concepts that are important to them. The girls often mentioned hands-on activities and experiments. However, it was for the most part not in the context or what's fun, but referred to what teaching strategies provided them with the most understanding. However, they did not hesitate to mention that making learning fun was necessary.

Throughout the focus group discussions, the girls spoke of their experiences with pedagogical strategies that they felt did/could provide them with the understandings which they sought. They often referred to hands-

on strategies in such contexts: "Probably (I need) like more hands-on stuff because it's kind of confusing when I don't understand stuff ... Maybe not as much reading and taking notes as actually seeing something, talking about it, or seeing how it actually works." Along this line, they suggested "more experiments", "draw(ing) pictures", "field trips", "(real-life) pictures", "skits", and "make(ing) models". "(Wait time) 'cause then you have more time to think through it." "I can remember everything because we studied it for a long time and it was very clear." "Like, apply it to different examples so we could understand it." The girls had experiences for which these strategies helped them to understand concepts. For example, one girl explained a science classroom in which she felt that she really learned something; she thought this was "'cause we do like writing assignments, and we also do like demonstrations, and we do computer and so it's a good mixture. . . ." Another reflected back on a really good experience and concluded that, "I think that if we wouldn't have done that fermentation with the bags and experiments, I wouldn't understand.. .."

However, the girls did not just stress such strategies. Several girls also expressed the need to have the teacher help them to understand the activity. For example, one commented:

> Yeah, and if the teacher explains it to you, 'cause sometimes it'll be like OK you need to do this experiment, and you won't know what the experiment's about because they haven't explained anything. They explain it real well and then you understand it.

Another expressed the same feeling that she felt that teachers should ". .. sometimes explain it more. ..." But, others in the groups were quick to guard against too extreme of an attempt to make the activity meaningful. One girl used an example of a field trip in which the activity was too structured: "Like our scavenger hunt at the Historical Society—1 was trying to keep up and keep writing down everything — I didn't really understand anything because I was too busy trying to find all the answers." Another in her group agreed: "We didn't have time to enjoy it."

They contrasted these strategies that support understanding with more traditional methods: "I just have to memorize the cells and I don't like to memorize them." "I feel that the lessons went kind of fast, all we did was read the chapter, we reviewed, and we did do a project once in a while or the teacher drew diagrams, and then we'd take the test and it was over. And I don't think that the kids, or my peers, got it.. . ." "It's just really . . . we just. .. we never do anything to actually leam it. We just do this paper and then we have a test." "Like everyday she gives us a different study guide and no-one actually uses it."

Evidence could also be found to support the fact that the girls were also concerned about having fun while they learned. These were often identified through the use of "hate", "fun", and "like", which are words that describe how they enjoyed the activity — not what they learned from it. Such comments as "I hate reports", "I don't like computers", "I used to hate ... to bring in articles about current events" or "experiments are fun" were used (although not nearly as extensively as comments that signified a need to understand). One student even suggested that "I think that it would be cool, like if they had like every semester, just one day a semester to have something fun. I mean like something that takes the whole day for every team. You know, something fun."

The girls in this study were seeking a real understanding of the science in their world. They identified with those strategies that they felt not only supported their efforts to understand, but also made it enjoyable to be in the science classroom.

3.2. *What the Teachers Heard*

The written responses submitted by the teachers were analyzed according to the coding system. An initial review of the coded transcripts revealed that there was no significant difference between the responses of the male teachers and the female teachers, and therefore the responses were categorized as one group. The categories were checked for completeness. This analysis revealed the categories discussed below.

3.2.1. *We 'Like' to Learn About Our World and Ourselves*

Some of the teachers who conducted the interviews were impressed with the fact that the girls were "genuinely interested and excited about science". They were also surprised at the amount of learning that was taking place outside the science classroom. "I was surprised that the students have been doing a variety of science-related activities outside of school." However, there was evidence that the teachers see this as what the girls 'want', instead of what they expressed they 'needed' in order to understand science.

The teachers 'heard' the girls express a need to connect what they are learning in the science classroom with everyday life. One teacher remarked: "Real life connections need to be better addressed." Another teacher supported this notion: "From the interview, I was reminded (of) how much the girls like to relate the activities to daily life." Another comment was: "Some of the ideas that the girls thought should be learned in science are the concepts that they felt that everyone should be aware of." In his re-

flection on what the girls wanted to learn about, one teacher pointed out that "girls gave practical reasons for wanting to know".

However, some teachers didn't seem to connect this need to the learning that was/was not occurring in the classroom. This is suggested in such remarks as the one made by one teacher when she was trying to figure out why the girls couldn't 'discuss' anything that they did in her class. "(I don't know) why many have forgotten the previous science concepts that they have learned." However, she reasoned: "If I would have brought up science topics and asked them what did they learn during those units, I am sure that they would be able to understand." In addition, key phrases such as "like to relate the activities to daily life," and "want to see real world connections" were found throughout the reflections on this topic.

For the most part, the teachers did 'hear' the girls ask to learn topics that related to the science that affects their everyday life. However, they did not appear to connect this to the girls' search for understanding of the world around them. Instead, it was often looked at as something that the girls were requesting, namely, to be pulled into the existing curriculum because they 'liked' it.

3.2.2. *Choice*

This request would mean a change in the power structure of the classroom; however, no teacher commented on how such a request would affect their classroom and only one response could be found that acknowledged this request at all. One teacher commented that "they like choice". However, this was the only reference in her reflection to this idea. Despite an extensive list of comments by the girls that could be coded in this category, no other teacher made any reference to this request.

3.2.3. *We Want to Have Fun*

The teachers did 'hear' that the girls wanted more hands-on activities. However, this was connected to the fact that the girls just wanted to have 'fun' in the classroom.

The teachers made many references to the fact that the girls wanted to do more hands-on types of projects. "It was clear that they really enjoy the hands-on activities in science." "The theme that I noticed throughout the girls' discussion was that they wanted to be enjoying themselves when they were learning. They wanted to play games and do projects. They did not like lectures or worksheets." In addition, they heard that the girls had a "keen desire to investigate". Other pedagogical practices that they heard the girls call for were "more movies", "current events", and "wait time". However, the teachers attributed the girls' request for more hands-on activities, experiments and projects to the fact that middle-school girls just want to have fun. As one teacher commented: "They want action and fan. They still believe that learning should be fun and enjoyable and practical." The teachers did not reference the fact that the girls often mentioned such activities as they were describing lessons in which they learned.

3.3. *How the Teachers Will Respond*

The teachers were asked to write a statement about what classroom adjustments they would make as a result of what they heard the girls say. Type, reason, and frequency of response were then used to code the described adjustments. An analysis of the resulting categories revealed the following.

The comments that the teachers made, about how what they learned from the girls should/will affect their practice, were overwhelmingly concentrated on current events. An extensive number of comments were coded for this category. "I can have current events day in my classroom." "I also have Current Science magazines that we use as a class, and I could incorporate that more within each class." "Our classes will utilize the newspaper for current events."

The one teacher who did reference choice stated that "I am not sure how that (desire for choice) can be translated to science when there are certain guidelines that have to be met, but it might be possible to do some choice learning".

There were additional comments made. "I need to build in more projects and games." "I need to try to remember always to try to relate the Earth science concepts to their daily life." "I am looking for a lab manual with shorter, less costly labs . .. we could begin charging a fee that could be used for more supplies." We could "trim the number of topics covered to about eight a year". "They feel that the boys think that they are dumb and prefer to have a partner of their own sex... an ideal group would be a girl pairing up with another girl and the same for the boys." However, these implications were scattered references, with most only being referenced once or twice.

Several of the teachers mentioned the conflict between making the classroom more fun and meeting curriculum guidelines. One of these teachers made an extensive effort to justify why she can't do anything different as a result of what she heard the girls say:

> My concerns with these topics (hands-on, real-world connections) are that it's possible that elementary educators have not covered science as per curriculum guidelines — be-

cause they might have focused more on other areas such as reading and math. If that is the case, the basic foundation of science was not initially met, and so the big ideas and vocabulary are not present to build an understanding of the next concepts . . . Learning in the 'fun' context is not always a reliable way for them to leam. My concern with doing hands-on projects on a regular basis could be 'fun', but is there real learning taking place, and how do we measure that without a paper/pencil test ... the basic foundations of vocabulary and reading comprehension of the concepts are the focus (here) to prepare them for the next level?

These teachers revealed how their perceptions of the girls' requests, coupled with the stress of 'certain guidelines9, support the fact that they cannot adjust the curriculum in the light of what the girls told them. For them, the girls' requests were perceived as things that they wanted for the sake of making the classroom 'fun9, and this cannot be done in the light of serious matters such as curriculum guidelines and preparation for the next level of education.

4. Conclusion

Over the past two decades, research has increased our understandings on the development of adolescent girls. Girls base their identity on connection and relatedness to others (Gilligan, 1993; Lyons, 1983). The findings from the first section of this study support this notion. The girls attempted to communicate their emerging ideas and questions about their relatedness to the physical world. They talked about their world and their bodies and expressed a desire to leam more about them. The dialogue between them revealed that they wonder about such things as deodorant-causing cancer, harmful emissions from local businesses, and their pets. They expressed a frustration with a science classroom that pushes them to memorize disconnected information, such as chemical equations, instead of helping them understand their world. Overall, the girls did find the knowledge needed to help them to understand themselves in relation to others: material, animal, or human.

Based on the girls' responses, a teacher seeking to respond to the girls from an inclusive perspective would seek to use science content to help these girls to understand themselves and the world around them. The content would be used to answer such questions as "Will deodorant (an item being discussed in adolescence) cause cancer?", "Does your pet remember you?", or "What is that smoke coming out of the pipes in your community?" "Is it harming your body?" However, the teachers in this study did not respond from an inclusive standpoint.

The teachers' reflections raised questions as to how they perceived the girls, as well as the nature of identity formation and the role of the public school. The teachers heard the girls ask for real world connections. However, this was understood as a need to make the classroom fun, suggesting that the teachers perceived the girls as being immature — believing that "learning still should be fun and enjoyable and practical". These teachers perceive the girls as having a deficit in an area—maturity. In addition, the teachers' responses revealed that they felt that it was their role to take the girls from the point where they are and help them to fit into the science curriculum, suggesting a perceived need to assimilate the girls into the identity of a mature and educated person. Their responses to the girls emphasized the existing curriculum with minor adjustments being used to help the girls to fit into that curriculum by making connections to things in the world. Their responses did not begin with the girls' questions and bring in science; they started with the science curriculum and sought to bring in the girls.

One of the most intriguing findings of this study is in the area of choice. The concept of student choice being incorporated into the science classroom was often referred to in the girls' dialogue. However, it was only mentioned once in teachers' responses. The silence on this topic could reveal more about the teachers than what they did say. The teachers in this study did so on a volunteer basis. They were interested in helping the girls in their science classrooms. However, the girls' request for choosing what they study would mean that the girls were in control of making the classroom more inclusive to their needs. They did not want the teacher to make the adjustments; they wanted to do it themselves. As one girl said, ".. . you've (teacher) got to bend a little ... We've got to have input in what we're going to be learning—what's going to affect our future." Granting such a request would mean that the teachers would have to give up control. They would not be helping the girls, but standing aside and letting the girls help themselves. Such a move could be especially difficult for teachers who perceive themselves as advocates for adolescent girls, for it would mean that they would have to question their existing beliefs about what it means to be champions for these students (Freire, 1993). In the reflection process, they would have to acknowledge that their own prior actions, in selecting the topics and pedagogical strategies that they feel the girls need, could actually have been supporting a repressive environment.

The findings of this study reveal that the dialogue from adolescent girl to teacher response broke down. The resulting teacher responses, by means of classroom actions, tended to be simple strategies fitting into the existing structure—a structure that historically has not supported the girls' iden-

titles. Maher and Tetreault (1994, p. 91) point out that classrooms are communities of discourse where girls' voices "evolve in a complex interplay between the individual, the group, the teacher, the academic discipline, and the institutional context". In these middle-level science classrooms, adolescent girls are attempting to shape their voices within an area that is not yet responding to their attempts:

> When those who have the power to name and socially construct reality choose not to see you or hear you. . . when someone with the authority of a teacher, say, describes the world and you are not in it, there is a moment of psychic disequilibrium, as if you looked into a mirror and saw nothing. (Rich, as cited in Maher & Tetreault, 1994, p. 201).

The girls in this study were seeking inclusion in the science curriculum. The findings from their dialogue with the teachers show that the girls' request for inclusion will be answered with simplistic assimilative strategies that will continue to foster an environment that does not reflect their identities.

5. Implications

The findings of this study show that the dialogue from adolescent girls to teacher response broke down. This has implications for the practice of teacher development. It is going to take more than providing teachers with the words that adolescent girls say in order to foster an inclusive atmosphere, noting again that voice is being used in reference to an individual's point of view or understanding of reality and not just allowing words to be spoken. Teachers need to be prepared to respond in a way that will foster voice. The findings of this study also lead to new inquiries. What causes the dialogue to break down? Are there external barriers that prevent such a dialogue from occurring? What role does/should curricula have in the process of fostering the voice of adolescent girls? These questions have implications for future research.

5.1. *Implications for Practice*

The study has implications for teacher professional development. The teachers who took part in this study did so on a volunteer basis. They were interested in giving girls a voice in science education. Despite their interests, and their experience with listening to the girls, their responses did not support the changes sought by the girls. The findings show that teachers did not have, or did not know how to utilize, the knowledge and skills

necessary to respond to the girls. Providing them with the skills and knowledge they seek will take professional development. A review of the seven principles that guide effective professional development practices (Loucks-Horsley, Hewson, Love & Stiles, 1998, pp. 36—37) provide insight into the extent of effort such professional opportunities will require. The creation of programs that meet several of the key components of professional development, in respect to achieving an inclusive atmosphere, will require preparing the teachers for critical praxis. Critical praxis refers to the interactive, reciprocal shaping of both theory [voice] and practice [classroom] (Lather, 1986). Specific components necessary for professional development suggested by the findings of this study are consistent with Loucks-Horsley's critical components of professional development include such things as: (1) experiences that allow the teachers to develop and foster their own professional identities (voice); (2) collaborative groups of teachers who share the goal of changing the classroom environment; and (3) preparing teachers to solicit district and community support for the establishment of inclusive classrooms.

One area of professional development that is showing promise of achieving such experiences and skills is action research, which also is termed 'teachers as researchers' or 'reflective practitioners' (Berge & Ve, 2000). The aim of action research is to improve practice by using a professional eye to observe our own practice (Arhar, Holly & Kasten, 2001). Action research projects that focus on gender issues in education have spread throughout the world. In regards to using teacher research as a structure for professional development, action research, completed with an eye on the theory between voice and classroom practice, could disempower through reification and recipe approaches (Bower, 1984) that have historically dominated the classroom environment. These approaches respond to one dominant voice. Action research could greatly benefit teachers, such as the ones explored in this study, who actively seek approaches that will give adolescent girls a voice in science education. Questions do remain for the researcher in regards to the effect of such professional development opportunities that involve teachers that do not begin with this inquiry. However, the scope of this study did not include such teachers; thus, insight into the dialogue that would include such teachers was not explored.

5.2. *Implications for Future Research*

5.2.1. *Separate/Connected Knowers*

The dissonance that occurred in the dialogue from adolescent female voice to teacher response suggests to the researcher differences in procedural

knowledge—connected and separate knowers. Belenky et al. (1997) compare the connected with the separate knower. Connected knowers seek to understand truly an object, idea, or person. They establish a type of personal acquaintance by caring and accepting this other. Separate knowers seek knowledge of an object, idea, or person. They seek mastery by meeting standards for evaluation. Although identification of these different approaches to procedural knowledge was not the aim of this study, the findings suggest that the adolescent girls were seeking an understanding of science (suggesting connected knowers) while the teachers were responding to a desire to foster knowledge of science (suggesting separate knowers). Females who start out as connected knowers often leam how to approach knowledge from a separate perspective; thus most science teachers, female or male, might have come to approach learning/knowledge from this manner. This leads to new inquiries. Does fostering the girls' identities mean fostering connected knowers? Can teachers who are separate knowers foster such identities? Is it possible to foster the voices of the connected knowers in a public classroom? More research is needed on the development of connected knowers within the science classroom.

5.2.2. *Curriculum Development*

Mayberry (1998) argues that content and pedagogy must be transformed if science education is going to become more inclusive. The findings of this study do raise some questions as to the role that curriculum could serve to create an inclusive classroom for adolescent girls. In light of what the girls said, developers can create a curriculum that (1) provides content that is explicitly related to the girls' world, (2) allows for choice, (3) provides pedagogical support for understanding, and (4) is fun. However, our emerging understanding of the relational needs of girls (Gilligan, 1993) suggests that it is the human relationships created in the classroom that either foster or stifle their voices, and the classroom environment will have an impact on the success of any curriculum project (Saures, Pias, Membiela & Dapia, 1998) aimed at fostering an inclusive environment for adolescent girls. Can such a curriculum be provided without teacher development? Can these new curricula serve as a vehicle to initiate a change in the classroom environment? Or will their fate depend on extensive teacher development programs to accompany the curriculum?

Historically, science has been shaped by one voice — the White, Western, masculine voice. Science will never be truly impacted by the voices of'others9, if we continue to foster only that one voice in the science classroom. Fostering a science that values and responds to many voices will take a more extensive and holistic approach to change.

In conclusion, this research was one step in describing the conversation that occurs, or does not occur, between teachers and students. The voices represented in this article do not represent all under-served populations in science education. In addition to research that responds to the questions raised above, future research is needed to help to further understanding of the experiences ofESL, non-white, lower-socioeconomic girls and boys. If science is to benefit from the voices of 'others', science education must leam to 'listen' to the voices of ALL adolescents.

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References

Arhar, J., Holly, M., & Kasten, W. (2001). *Action research for teachers: Traveling the yellow brick road*. Columbus, OH: Prentice Hall.

Atwater, M., Crockett, D., & Kilpatrick, W. (1997). Constructing multicultural science classrooms: Quality science for all students. In J. Rhoton & P. Bowers (Eds.), *Issues in science education* (pp. 167–176). Arlington, VA: National Science Teachers Association.

Belenky, M., Clinchy, B., Goldberger, N., & Tarule, J. (1997). *Women's ways of knowing: The development of self, voice, and mind* (2nd ed.). New York: Basic Books.

Berge, B., & Ve, H. (2000). *Action research for gender equity.* Philadelphia, PA: Open University Press.

Bower, C. (1984). *The promise of theory: Education and the politics of cultural change.* New York: Longman.

Brown, L., & Gilligan, C. (1991). Listening for voice in narratives of relationship. *New Directions for Child Development,* 54, 43–62.

Freire, P. (1993). *Pedagogy of the oppressed.* New York: Continuum.

Gaskill, J., Hepbum, G., & Robeck, E. (1998). Re/presenting a gender equity project: Contrasting visions and versions. *Journal of Research in Science Teaching,* 35, 859–876.

Gilligan, C. (1988). Exit-voice dilemmas in adolescent development. In C. Gilligan, J. Ward, & J. Taylor (Eds.), *Mapping the moral domain* (pp. 141–158). Cambridge, MA: Harvard University Press.

Gilligan, C. (1993). *In a different voice: Psychological theory and women's development.* Cambridge, MA: Harvard University Press.

Gilligan, C., Lyons, N., & Hanmer, T. (1990). *Making connections: The relational worlds of adolescent girls at Emma Williard School.* Cambridge, MA: Harvard University Press.

Guba, E. (1978). *Toward a methodology of naturalistic inquiry in education evaluation* (CSE Monograph Series in Evaluation No. 8). Los Angeles: University of California, Center for the Study of Evaluation.

Harding, S. (1991). *Whose science? Whose knowledge?* Ithaca, NY: Comell University Press.

Hughes, G. (2000). Marginalization of socioscientific material in science-technology-society science curricula: Some implications for gender inclusivity and curriculum reform. *Journal of Research in Science Teaching,* 37, 426–440.

Jones, M., & Wheatley, J. (1990). Gender difference in teacher-student interactions in science classrooms. *Journal of Research in Science Teaching,* 27, 861–874.

Jovanovic, J., & King, S. (1998). Boys and girls in the performance-based science classroom: Who's doing the performing? *American Educational Research Journal*, 35,477–496.

Kahle, J., & Lakes, M. (1983). The myth of equality in science classrooms. *Journal of Research in Science Teaching,* 20, 131–140.

Lather, P. (1986). Research as praxis. *Harvard Educational Review,* 56, 257–277.

Loucks-Horsley, S., Hewson, P., Love, N., & Stiles, K. (1998). *Designing professional development for teachers of science and mathematics.* Thousand Oaks, CA: Corwin.

Lyons, N. (1983). Two perspectives: On self, relationship and morality. *Harvard Education Review,* 53, 125–145.

Maher, E, & Tetreault, M. (1994). *The feminist classroom.* New York: Basic Books.

Mayberry, M. (1998). Reproductive and resistant pedagogies: The comparative roles of collaborative learning and feminist pedagogy in science education. *Journal of Research in Science Teaching,* 35, 443–449.

Meece, J., & Jones, G. (1996). Gender differences in motivation and strategy use in science: Are girls rote learners? *Journal of Research in Science Teaching,* 33, 393–406.

Rodriquez, A. (1998a). Strategies for counterresistance: Toward sociotransformative constructivism and learning to teach science for diversity and for understanding. *Journal of Research in Science Teaching,* 35, 589–622.

Rodriquez, A. (1998b). What is (should be) the researcher's role in terms of agency?: A question for the 21st century. *Journal of Research in Science Teaching,* 35, 963–965.

Saures, M., Pfas, R., Membiela, P., & Dapia, D. (1998). Classroom environment in the implementation of an innovative curriculum project in science education. *Journal of Research in Science Teaching,* 35, 655–671.

Tobin, K., Kahle, J., & Fraser, B. (Eds.). (1990). *Windows into science classrooms: Problems associated with higher-level cognitive learning.* New York: Falmer Press.

Wilkinson, S. (1999). How useful are focus groups in feminist research? In R. Barbour & J. Kitzinger (Eds.), *Developing focus group research: Politics, theory and practice* (pp. 64–8). Thousand Oaks, CA: Sage.

Willis, S. (1996). Gender justice and the mathematics curriculum: Four perspectives. In L. Parker, L. Rennie, & B. Fraser (Eds.), *Gender, science and mathematics: Shortening the shadow* (pp. 41–51). Boston: Kluwer.

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