Paying the Price for 'Sugar and Spice' - Shifting the Analytical Lens in Equity Research.

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Abstract

The analytical stance taken by equity researchers in education, the methodologies employed, and the interpretations that are drawn from data, all have an enormous impact upon the knowledge that is produced about sources of inequality. In the 1970's and 1980's, a great deal of interest was given to the issue of women's and girls' underachievement in mathematics. This prompted numerous different research projects that investigated the extent and nature of the differences between girls' and boys' achievement and offered reasons why such disparities occurred. This work contributed towards a discourse on gender and mathematics that flowed through the media channels and into schools, homes and the workplace. In this article I will consider some of the scholarship on gender and mathematics, critically examining the findings that were produced and the influence they had. In the process, I will propose a fundamental tension in research on equity, as scholars walk a fine and precarious line between lack of concern on the one hand, and essentialism on the other. I will argue in this article that negotiating that tension may be the most critical role for equity researchers as we move into the future.

“What are little girls made of?

Sugar and Spice and all things nice”

Nursery rhymes and limericks of old are not known for their sensitive or accurate portrayal of social relations, and the sugar and spice characterization above may simply appear foolish or humorous from a modern-day perspective. But I will argue in this article that the essentialism captured by this and other nursery rhymes has also been a characteristic of many gender analyses and that these may have served to sustain, rather than eradicate, inequities in schools. I will also suggest that as mathematics educators move from a long tradition of gender research to an emerging focus upon the relationships between culture, ethnicity, and mathematics achievement, we may learn from the precarious path walked by our predecessors in equity research. In this article I will present some data and prior scholarship on gender and mathematics in order to consider the ways in which 'gender', as a construct, has been located and framed, and the implications of such framing for equity analyses more broadly. This will uncover a fundamental tension in equity research, as scholars walk a fine and precarious line between lack of concern on the one hand, and essentialism on the other. I will argue that negotiating that tension may be the most critical role for equity researchers as we move into the future. Further, I will propose that reflexive discussions of the ways in which inequalities are located and framed need to be central to any analyses of equity.

In the 1970’s and 80’s a great deal of interest was given to the issue of women’s and girls’ underachievement in mathematics. This prompted numerous different research projects that investigated the extent and nature of the differences between girls' and boys' achievement and offered reasons why such disparities occurred. But many of the analyses that were produced positioned girls in essentialist ways, attributing anxiety and underachievement as stable characteristics that are as potentially damaging as the 'sugar and spice' labels of old. Thus, researchers searched for the origins of girls' under achievement but even when these were linked to pedagogies or environments, they were generally presented as characteristics of girls, rather than co-productions of people, society, and environment (Butler, 1993; Bateson, 1972; Geertz, 2000).

Carol Dweck (1986), for example, has produced a number of influential analyses in which she concludes that girls, particularly those she terms 'bright' girls, have maladaptive motivational patterns, that include avoiding high risk learning situations and preferring situations in which they are sure to succeed. She claims that students with maladaptive patterns seek situations that will lead to correct answers, rather than those that are challenging and provide opportunity for learning. This characterization captures the essentializing to which I refer. Dweck offers 'maladaptive' tendencies as a reason for the lower mathematical performance of some girls, particularly at advanced levels, but she treats these motivational patterns as inherent characteristics of girls that exist outside the settings in which girls are taught. This seems to be a fundamental flaw as motivations must surely be highly situated. If we *were to* consider the tendencies Dweck noticed among "bright girls", outside of their setting, we might conclude that the tendencies were indeed 'maladaptive' in the sense that they were unproductive. But if we consider the system in which students were learning, we may view the tendencies of girls as highly adaptive. The majority of 'bright' girls are taught mathematics in high ability groups in which the attainment of correct answers, at a fast pace, is what is valued. In such an environment choosing to seek situations that will lead to correct answers, seems sensible and highly *adaptive*. The notion of adaptivity – central to theories of natural selection – rests upon environmental responsiveness, and the idea that 'girls' have maladaptive tendencies contravenes that basic premise. A different analysis would consider the constraints and affordances (Gibson, 1986 Greeno & MMAP, 1998) provided by the environments in which girls work, that lead to such responses.

The difference between the two approaches I have mentioned – one which considers the girls as maladaptive, the other that focuses on the teaching environments which produce such tendencies – is that the first would lead to recommendations to change the girls. Indeed Dweck's proposed solution is to design "appropriate motivational interventions" (p. 1045) for girls, placing the burden for change upon them (Rogers & Kaiser, 1995). The second interpretation would lead to recommendations to change the teaching environments in which students are working, environments that produce motivational patterns that are unproductive for learning.

The tendency to attribute certain characteristics and attributes to girls and women reflects a wider societal regard of gender. Even those people who believe that males and females have equal intellectual potential, and vary to the extent to which they conform to stereotypes, generally regard gender as a characteristic of the different sexes, rather than a response to a particular set of conditions. Researchers have traditionally proposed, implicitly or explicitly, that women *have* a gender, which comprises a set of characteristics shared by the wide group of people in the world who are female. But gender, as Butler (1993) has argued, is a *response* that emerges in certain situations, and its analytical home should not be people, but the interactions that emerge in practice. Culture is also a co-construction, as Cobb and Hodge (2002), and Gutiérrez (2002) argue in this special issue. It emerges in different forms in the home, the school and the workplace, and it is constantly negotiated and renegotiated through everyday interactions. Yet culture, like gender, is generally conferred upon people and groups as a static and immoveable set of competencies, attitudes, and dispositions. When the National Council of Teachers of Mathematics (NCTM) in the US, released books offering 'Perspectives on African Americans' ‘Latinos' and ‘Asians’ they communicated a number of good teaching approaches and a concern for equity, but they also essentialized these groups, suggesting that African American or Latino students possess particular preferences for learning styles or teaching approaches, by virtue of their ethnicity or culture.

Cohen (1999) gives an important historical perspective on the tendency of researchers to locate underachievement within certain groups of students. She analyzed the recent furor in the UK that has been prompted by national examination data showing that girls are now ahead of boys in almost all subjects (mathematics being a notable exception). In doing so she points out that female underachievement has always been partially accepted as a corollary of being female, whereas the idea of male underachievement has prompted recent, widespread investigations into the *external* culprits:

> Boys achievement has been attributed to something within – the nature of their intellect – but their failure has been attributed to something external – a pedagogy, methods, texts, teachers. The full significance of this becomes clear when the

> subject of the discourse is girls, for in their case it is their failure which is attributed to something within – usually the nature of their intellect – and their success to something external: methods, teachers or particular conditions. (1999, p20)

The application of internal rather than external reasons for the underachievement of students is evident within many strands of equity research. Cohen traces this trend through English history to show its origination in the 17th century and its incredible resilience in the intervening 300 years. At that time scholars went to enormous lengths to explain away the achievement of girls and the working classes, as it was boys, specifically upper-class boys, that were believed to possess true intellect. This required the construction of the idea that any quickness and superior verbal competence noted amongst girls or working class students was a sign of weakness:

> The English gentleman's reticent tongue and inarticulateness which had been unfavourably contrasted with the conversational fluency of English women and of the French for most of the eighteenth century now became evidence of the depth and strength of his mind. Conversely, women's conversational skills became evidence of the shallowness and weakness of their mind. (Cohen, 1999, p24)

In 1897 Bennett argued that boys appeared slow and dull because they were thoughtful and deep and "gold sparkles less than tinsel." "Thus as the eighteenth century came to a close, girls' brightness, construed as inferiority, and boys' dullness construed as potential, were woven into the fabric of gender difference" (Cohen, 1999, p25).

The ideas of Bennett and others may (hopefully) appear ridiculous now, but their vestiges are evident within current perceptions and discourse. Cohen relates these early ideas to the present-day beliefs of some boys that studiousness and scholarly interest are feminine traits and that 'Real Englishmen' (Mac an Ghaill, 1994, p70) do not try hard in school. 'Effortless achievement' is a key concept in the English aristocratic attitude to education and constructs not only the power of the English gentleman but his 'other', the swot, whose hard work is the very evidence of his lack of 'natural' intellect: the 'scholarship boy', academic achievers such as the working-class boys in Mac an Ghaill's study, *and all females*. (Cohen, 1999, p29, italics added).

Varenne and McDermott (1999) address the essentialism and inward tendencies that lurk within equity analyses by offering two metaphors for culture. In the first, culture is represented as the "habits we acquire" (1999, p14) as we go through life. This view of culture is one that is traditionally found in analyses of school achievement, with many researchers proposing that a students' culture or class may be thought of a set of habits or characteristics that are acquired (Bourdieu, 1982; 1986). This leads to the idea that the successful in school are those that are properly socialized into the dominant culture and the unsuccessful are those that are not (Bourdieu, 1982; 1986; Zevenbergen, 1996; Delpit, 1988). In their second, preferred metaphor, Varenne and McDermott suggest that culture be represented as "the houses we inhabit" (1999, p14). This allows for the fact that being Black, working class, or a girl, for example, only matters in some places. When people are working among others of the same culture, class, or gender, such categories become invisible. Yet researchers who consider the sources of inequity for students of minority ethnic and cultural groups often fail to capture the shifting and relational nature of culture. Varenne and McDermott (1999) propose that school is a system that is “filled with instructions for coordinating the mutual construction of success and failure' and that categories such as ‘low achiever’ or ‘learning disabled’ are 'positions in education that get filled by children'” (pp. xxx-xxx). In doing so they relocate the focus, away from categories of people and the characteristics they bring, and towards a dynamic system that *produces* responses of achievement, underachievement, gender, culture, and class. This is an important repositioning and I will spend some time now considering what it may mean for equity analyses by examining the case of gender.

A Brief Review of Gender Research.

Gender differences in mathematics achievement have been documented and examined for over half a century, and in many countries in the World (Burton, 1990; Habibullah, 1995; Sukthankar, 1995; Delon, 1995; Kaur, 1995; Singh-Kaeley, 1995). For the purposes of this article, I will reduce the complexity of gender patterns in mathematics achievement to four facts that I regard as notable, current, and to which I shall return in my analysis. The first fact is that gender differences in mathematics achievement are generally small (Hyde, 1993) and insignificant when considered alongside the overlap in males’ and females’ achievement. Janet Hyde produced a meta analysis of gender differences in 1993, and even at that time – almost ten years ago – she found a minimal difference. She drew from over 100 studies involving 3 million subjects and derived an effect size of +0.15 standard deviations. Hyde demonstrated that gender differences were too small to be recognized as meaningful, and concluded that they have been overplayed and glamorized in the media which has contributed to a discourse of difference that has itself been implicated in the creation of differences in the achievement of girls and boys.

The second fact is that achievement differences have vastly diminished over time. That fact alone gives us important information about their origins, casting further doubt on the idea that gender differences may be attributed to genetic sources (Rogers, 1999). The third fact is that the greatest differences in mathematics achievement and participation are found at the most advanced levels. The evidence for achievement differences at high levels predominantly consists of results from short, closed tests, such as the SAT in the US, and the international Olympiad tests. Such tests persistently prompt small gender differences in favor of boys (Campbell & Clewell, 1999; Friedman, 1989, 1995). The fourth fact is that gender differences have tended to occur on mathematics questions that assess spatial ability and problem solving (Friedman, 1989). The first two of these four facts are highly positive and rarely regarded in gender analyses, the latter two have seriously negative implications and have been the subject of numerous analyses.

Consideration of the participation of women and girls in mathematics courses and occupations reveals varying degrees of inequality. In 1994, women made up 45% of those taking the advanced placement mathematics examinations in North American high schools and 47% of undergraduate degrees. However, only 24% of mathematics PhDs in the US go to women, and in 1992 only 6% of tenured university mathematics faculty were women. In other English speaking countries – such as Australia and England – the participation of women at degree and PhD level is lower. In the workplace, men vastly outnumber women in mathematically oriented occupations (Leder, 1990; Kenway, Willis & Junor, 1994).

One of the most persistent explanations for the differences that prevail in mathematics achievement and participation has focused upon the learning styles of boys and girls. For over a decade, 14-year-old students in the United Kingdom took mathematics and science tests that were designed and analyzed by researchers (Foxman, Ruddock & McCallum, 1990). The results of these tests regularly showed that girls out-performed boys on questions assessing arithmetic, whereas boys out-performed girls on questions designed to assess problem solving. Walkerdine (1989) constructed an analysis to explain these results. She proposed that girls are encouraged by teachers in school to be obedient and compliant – to accept mathematical methods as they are given and to learn by rote. Boys, she proposed, are encouraged to be adventurous and challenging. This leads girls to develop preferences for structured learning environments and boys to develop the propensity to challenge and change mathematical methods (Walden & Walkerdine, 1985; Walkerdine, 1989). This idea was not based upon any observations of students' mathematical activity, nor upon students' own reflections, but upon test results that were assumed to give indications of cognitive strategies and preferences. Walkerdine went on to challenge the notion that girls' success in mathematics was not the *right* sort of success because it was based upon rote learning and rule following, rather than rule challenging. Walkerdine's analysis had a pervasive impact on the community of mathematics educators in the UK. Unfortunately, whilst she formally challenged the idea that any form of girls' success should be negated, Walkerdine publicized a notion that girls are suited to rote and algorithmic approaches, an idea that took hold in many schools and that I will challenge in this article.

Learning style differences have been a recurrent theme in gender research in mathematics education. Despite the absence of data showing clear differences in learning style preference or tendency between girls and boys (Adey, Fairbrother, Johnson & Jones, 1995), a number of mathematics educators have offered the idea that girls employ learning styles that are fundamentally different (and inferior) to those of boys, and that limit their potential mathematics achievement (Walkerdine, 1989; Scott-Hodgetts, 1986; Bohlin, 1994; Fennema & Carpenter, 1998). I will consider some of these analyses in this article in order to raise a number of issues, not only about gender inequalities and learning styles, but about the focus of researchers, the methods employed in various fields, and the influence of different analytical perspectives on the conclusions that may be drawn about equity.

Gender and Teaching Environments.

A few years ago, I completed a detailed, longitudinal study of the achievement and participation of approximately 300 students in 2 secondary schools in England. I will briefly summarize the gender-related results of that study in this article in order to illustrate a different interpretive approach in equity research that leads to immensely different implications. In that study (Boaler, 1997) I monitored a cohort of students in each of the 2 schools over a three-year period, from when they were 13 to when they were 16. The two schools taught mathematics in completely different ways. At 13, before the students embarked on their different mathematical pathways, there were no significant differences in mathematical attainment of the two cohorts and there were no recorded gender differences at either school. Three years later the girls who attended the school that I have called Amber Hill, that followed a traditional, procedural approach, attained significantly lower mathematics grades on the national examination than the boys at their school. In the other school that I have called Phoenix Park, where an open-ended, project based approach was employed, there were no gender differences between girls and boys at any level and the students attained significantly higher grades than the students at the more procedural school. In questionnaires given to the students each year that asked them about their confidence and enjoyment, the boys at the two schools did not respond significantly differently. But the girls at the project-based school, Phoenix Park, were always significantly more positive and confident than the girls following a procedural approach at Amber Hill (Boaler, 1997a, b, c).

In that study, I observed approximately 100, one-hour lessons in each school over three years, and I conducted in-depth interviews with 80 students. Those methods, alongside the questionnaires and assessments that I gave the students, helped me to understand the source of the differences in the girls' responses to their different mathematics approaches. I will summarize this analysis by saying that many of the girls in the school employing a procedure-oriented mathematics approach (Amber Hill) became disaffected about mathematics when the pedagogy of the classroom became more traditional. Further, many more girls than boys at the school developed a preference that I have called a *quest for understanding.* At Amber Hill, the teachers presented abstract methods that students were required to practice every lesson. This was problematic for many of the girls, not because they were incapable of attaining success in such an environment. They were able to take the methods they had been given and reproduce them in textbook exercises. But many of the girls wanted more. They wanted to locate the rules and methods they were introduced to within a wider sphere of understanding. Thus they wanted to know *why* the methods worked, *where* they came from, and *how* they fitted into the broader mathematical domain. The boys at Amber Hill also preferred approaches that gave them access to a more relational understanding of connections within and across the mathematical domain. When I asked students to name their best ever mathematics lesson in a questionnaire, 81% of girls and 80% of boys chose the open-ended projects they worked on for two weeks of each year (n=160). But in the absence of such opportunities in their day-to-day mathematics lessons, many of the boys turned mathematics into a kind of game, re-positioning their goals by focusing on competition and *relative* success. Many of the girls would not re-orient their goals in this way and instead continued to strive towards depth of understanding, which worked to their disadvantage within that particular classroom system.

Phoenix Park school, in which I also monitored students for three years, offered the type of mathematics environment that the girls at Amber Hill appeared to yearn for. The students worked on open-ended projects, usually in groups, and they were given explicit encouragement to think about how, when, and why mathematical methods worked. At this school, there were no gender differences in achievement, at any level, and the students attained significantly higher examination grades than the students at

Amber Hill, even though there had been no significant differences in the students' attainment three years earlier before they began their different mathematics approaches.

The differences that emerged from that study of teaching and learning appear to challenge a number of the interpretations that had been offered for girls' underachievement in the past. For example, girls at both schools sought a deep, conceptual understanding of mathematics, and those taught by teachers who encouraged the exploration of mathematical ideas were able to achieve this goal. This finding stands in stark contrast to the conclusions of other gender researchers in mathematics education, who have decided, for example, that women are serialists (Scott-Hodgetts, 1986), that they prefer rote and algorithmic approaches (Walkerdine, 1989), and that they are less likely to develop conceptual understanding in response to a reform-oriented curriculum (Fennema & Carpenter, 1998; Sowder, 1998). The researchers who drew such conclusions all noted that boys out-performed girls on some tests, but none of the researchers observed the students' teaching environments or interviewed the students about their learning. As a consequence, they did not have adequate data from which to draw conclusions about sources of inequality. In the absence of such data, they were left only to speculate that the girls were lacking in some ways. This argument also holds for a number of studies conducted in the 1970's and 1980's that reported that girls achieved less than boys in tests of problem solving The inherent deficiencies attributed to girls on the basis of these results seem questionable when we note that the majority of students taking part in such studies were asked to solve problems in tests that stood in direct contrast to the teaching approaches they experienced in school. Thus the lower performance of girls in such instances may reflect their responsiveness to their teaching.

If the Amber Hill students had taken such tests, similar gender differences would probably have resulted. But the beliefs and achievements of the girls at Phoenix Park show that girls do not have to underachieve or become disaffected in relation to school mathematics and that such responses may be more appropriately considered *as responses* to particular teaching environments. Gender inequities are co-produced, and the conclusions drawn from analyses that leave students' instructional experiences out of the equation (often because of methodological restrictions) may be extremely misleading.

There were a number of indications from my study that many of the girls at both schools had developed preferences for what Gilligan describes as a kind of 'connected knowing' (1982). Thus they wanted to understand the connections between mathematical methods, and why they worked. Many of the boys at Amber Hill did not express such preferences and seemed content to manipulate abstract methods without considering their connections or relations. The problem for many girls in the past may have arisen because traditional mathematics environments have not allowed a connected, relational understanding (Boaler & Greeno, 2000; Boaler, 2000). This has not always stood in the way of girls' success, but it may have contributed significantly to their participation. Such preferences, whilst they were more prevalent among girls than boys, only became significant in certain teaching environments. This suggests that connected knowing may be less accurately represented as a characteristic of women, as it has been in Gilligan's work, than a response to certain learning situations. The data I collected appeared to indicate that such preferences are highly situated and that different approaches to school mathematics vary in the extent to which they encourage and satisfy such preferences.

Two years ago I gave a talk in England to a group of teacher education students about the possible gender related preferences that students may develop in certain teaching environments. After the presentation three young women approached me from the audience to talk about their experiences as undergraduate mathematics students. I conducted interviews with the women at a later stage. Surprisingly, in such a small group, all three of the women had been extremely high attaining mathematics students in school, winning prizes for their mathematics achievement and gaining the highest grades. They each went on to study mathematics at three of the UK's most elite universities. In England, students choose the subject focus of their undergraduate degree when they begin university. All three women started mathematics degrees but switched out of their programs after a relatively short time. They reported that the reason for doing so was because they wanted to understand the mathematics they were learning in the depth that had previously been available. In school they had been encouraged and enabled to understand the mathematics they met. But when they arrived at university they found they were expected to copy down endless formulas and procedures from chalk-boards. They reported that the men in their classes seemed content to do so, but the women wanted more. The three women all described how their love of mathematics ended and the severe distress that this caused them – one spoke of her relationship with mathematics to "spiral out of control". Two of the three women describe their experiences below:

> It was horrible for me because I had always found maths so easy and suddenly sitting there and not having the slightest clue what they were talking about. It was so abstract. To me it was the most meaningless thing I had ever heard. It seemed

> utterly pointless, utterly meaningless and stupid – we just copied at very high speed, I just had these pages and pages that I copied down from the board. (Imogen, Oxford University student)

> I think it was my fault because I did want to understand every single step and I kind of wouldn't think about the final step if I hadn't understood an in-between step (…) I couldn't really see why they, how they got to it. Sometimes you want to know, I actually wanted to know. (Julie, Cambridge University student)

The three women came from a very small and opportunist sample, but they gave important insights into the preferences they held for a certain way of knowing (Gilligan, 1982) that emerged *in response* to their university classes. These women, like many of the girls I interviewed at Amber Hill, talked about the importance of understanding, rather than simply following steps, and the harsh consequences of not understanding what they were doing. These students' accounts offer insights into the reasons why relatively low proportions of women continue with mathematics courses at university, despite their propensity to understand, that are entirely consistent with the views expressed by the students I have interviewed from a number of different high schools (Boaler & Greeno, 2000; Boaler, 2000)

There are many societal differences in the ways that girls and boys are treated (Singh Kaeley, 1995; Sukthankar, 1995), that would be likely to give rise to the different preferences for connected understanding in some teaching environments. But for mathematics educators it may be less important to understand why these differences occur than to understand the nature of teaching environments that preclude the realization of such preferences and turn the preferences of girls into anxiety and disaffection. If some teaching environments produce inequitable attainment through the creation of conflict between the preferences that girls develop and the opportunities that prevail, then it is important to question whether non-conflicting environments can be produced that are productive for the learning of mathematics. Phoenix Park school is not the only example of an environment that encourages equitable attainment (Silver, Smith & Nelson, 1995), but it is one site which may provide insights into the ways in which *teaching and learning practices* may promote equity (Boaler, 1997a, b, c; in press).

The results I collected from the Amber Hill and Phoenix Park schools may be interpreted in different ways. One interpretation would contend that the girls at Amber Hill had preferences for certain ways of working and that these were not supported by the procedural approach of their school. This interpretation (that I have offered in other publications) has some validity, but it also has potential dangers as it locates the preferences that emerged *within the girls*. Such an analysis would be consistent with the tradition of gender research, but part of the aim of this article is to move beyond such traditions and explore the additional understandings that new interpretations may produce. A different consideration of the data would highlight the fact that the gender responses were produced only within one of the two environments I studied, suggesting that the underachievement and disaffection of girls from Amber Hill was a co-production, with the mathematics environments playing a central role. Indeed, the vastly different responses and achievements of girls within the two different school environments would support the idea that environments rather than institutionalized categories, such as gender or culture, may be a more productive site for the location of equity analyses.

The relational analysis I propose above, which locates gender as a response that emerges between people and environments, may seem obvious and non-controversial, but it differs from traditional equity analyses in fundamental ways. In 1986, Scott-Hodgetts, for example, reviewed evidence from Pask (1976) for the existence of two distinct learning styles – serialist and holist. Serialists, she reported,

> prefer to proceed from certainty to certainty, learning, remembering and recapitulating a body of information in small, well-defined and sequentially ordered 'parcels' (…) Holists, on the other hand, prefer to start in an exploratory way, working first towards an understanding of an overall framework, and then filling in the details; they will tend to speculate about relationships during the learning process and will in general remember and recall bodies of knowledge in terms of higher order relations. (p68)

Scott-Hodgetts speculated that a higher proportion of girls are serialists. This conjecture was based upon "the pattern of development of mathematical performance of girls relative to boys" (p68). She, like Walkerdine, used test results to draw conclusions about attributes of girls, disconnected from any analysis of their learning environments. Scott-Hodgetts went on to draw links between holist approaches and higher-level mathematical understanding, and used this supposed characteristic of girls to explain their lower performance

The idea that girls may possess pre-dispositions to employ inferior cognitive styles became particularly prominent in a recent sequence of six articles that appeared as part of a special issue of *Educational Researcher* (1998). In this edition of one of the American Educational Research Association's leading journals, researchers from different fields offered their explanation for the gender differences that emerged from a study of 38 girls and 44 boys in grades 1-3 (Fennema & Carpenter, 1998). The students followed a reform curriculum for 3 years and were assessed on routine and non-routine problems each year. The researchers found no gender differences in the students' ability to solve problems, except for some higher achievement patterns amongst boys on extension tests. However, they found differences in the problem-solving strategies that boys and girls used in all grades. Girls tended to use concrete solution strategies and traditional algorithms, whereas boys tended to use more abstract solution strategies that they had invented. This result is given considerable importance by the authors and the editors of the journal, who suggest that it may explain all of the subsequent differences in mathematics achievement that occur between girls and boys.

Fennema and Carpenter, the authors of the study, recognize that such differences may be interpreted in different ways and called upon scholars from mathematics education, social psychology, and educational philosophy to give their interpretations. The collection is a significant contribution to disciplinary reflexivity, but it also conveys a message that gender inequities can legitimately be understood, absent from data on students' teaching and learning environments. Fennema and Carpenter discovered some important gender related patterns that they were not expecting, and so called upon different researchers to give their interpretations of the differences. But in the absence of data on teaching and learning environments, the different scholars had no option but to speculate about the reasons that differences emerged. This led to such statements as:

> The differential strategy use suggests: that because of the lesser degree of conceptual understanding, the girls are going to need to struggle more to succeed and that this struggle will be even harder for them because they will lack the self-confidence of the boys. (Sowder, 1998, p13)

In this statement, there is a shift from the girls' use of taught algorithms to a "lesser degree of conceptual understanding" and an implicit message that girls – not these girls in these teaching environments but the generic 'girls' – will struggle. My main concern with such comments, even when they are offered as hypotheses, is that they locate the reasons for under achievement *within* girls, rather than the broader environments in which they worked.

In this important collection of articles, Fennema and Carpenter invited the field to engage in the extremely worthwhile activity of thinking through and understand a case in which gender differences that emerged. It is important to stress that Fennema and Carpenter were concerned to understand these gender differences and to explore their origin with scholars from different disciplines. However, their lack of attention to the teaching and learning environments seems problematic for two main reasons. The first is that it underplays the importance of the particulars of teaching and learning (Chazan & Ball, 1999, Lampert, 1985) – the different scholars were told that the classes were following a "reform curriculum" and were presumed to know what that meant for classroom interactions. As the field of mathematics education has expanded to include analyses of different versions of 'reform' teaching (Cobb & Bauersfeld, 1995; Chazan & Ball, 1996; Gutiérrez, 1996, 1999; Boaler, 1997a, in press; Lubienski, 2000) we have become aware of the vastly different environments that may be created through slight variations in the practices of teaching. This tells us that it is insufficient to know that a teacher was “reform oriented.” My second concern for analyses that leave out the practices of teaching and learning is that researchers are inevitably left to draw conclusions about 'girls' and to position gender as a characteristic of groups of people, rather than a situated response.

The tendency to focus analyses of underachievement upon categories of students, rather than the environments that co-produce differences, is not unusual in equity analyses. In mathematics education, researchers have variously discovered that girls lack confidence, develop anxiety and attribute failure to themselves. These tendencies have generally been presented as properties of girls, rather than as responses that are co-produced by particular working environments. This has led educators to propose interventions aimed to change the girls so that they become less anxious, more confident, and *essentially* more masculine. The 1980’s spawned numerous programs of this type for girls that were intended to make them more confident and challenging (Rogers & Kaiser, 1995). In such programs, the responsibility for change is laid firmly at the feet of the girls and problems with mathematical pedagogy and practice, and with the broader social system are not considered. But the location of gendered responses *within* women and girls may be directly linked to the fact that early gender researchers worked within a positivist research paradigm, in which researchers were expected to control, rather than understand, variables such as teaching. These researchers analyzed test and questionnaire data and found gender related attitudes and achievements, but they did not have access to the teaching and learning environments that would have allowed them to understand the gendered responses. Contemporary educational researchers have the resources to investigate and understand the interactions of teaching and learning, drawing from different methods in order to produce “thick descriptions” (Geertz, 2000, p3) of the ways in which environments contribute to differential responses. An important responsibility of gender researchers in the future will be to build upon our predecessor's work and search for explanations of the differences they found, not within the nature of girls, but within the interactions that produce gendered responses.

Discussion and Conclusion

I have spent some time in this article arguing that gender, like culture, is a response rather than a characteristic. It is probably not appropriate or useful to seek a single true definition of either gender or culture as both involve a range of conceptions or models that are employed in a variety or circumstances and thus elude precise definition. But it may be important for researchers to examine and unpack the conceptions that they do employ. My preference for a situated, relational conception of gender and culture derives in large part from the implications that such conceptions carry for action and change, and for the responsibility they endow upon educational organizations for making change. We have a long history of equity research that has drawn conclusions about groups of people and publicized these, at some cost. In my interviews with high school students, I frequently encountered stereotypes about the potential of students from different sexes and cultural groups. But it is particularly disturbing to know that the prevailing idea that girls are mathematically inferior often derives from the findings of equity researchers. In a recent interview with a group of high school students in California, I asked two girls about gender differences:

JB: Do you think math is different for boys and girls or the same?

K: Well, it's proved that boys are better in math than girls, but in this class, I don't know.

JB: Mmm, where do you hear that boys are better than girls?

K: That's everywhere – that guys are better in math and girls are like better in English.

JB: Really?

B: Yeh I watched it on 20:20 [a television current affairs program] saying girls are no good, and I thought – well if we're not good at it, then why are you making me learn it? (Kristina & Betsy, Apple school)

The girls refer to a television program that presented the results of research on the differences between the mathematical performance of girls and boys. This extract speaks clearly to the ways categories of students are essentialized by the media, who generally draw upon research findings and present them in sensational ways. Headlines that have appeared in the media in recent years include the New York Times headline: "Numbers Don't Lie: Men Do Better than Women" with the sub-heading "S.A.T. Scores accurately reflect male superiority in math." But this article, like many others, was based upon research results and analyses that constructed performance difference as a characteristic of women, rather than a response to particular teaching and learning environments.

The girls' reflections above also speak clearly to the ways that such reporting may impact the motivation and confidence of students in schools – "if we're not good at it, then why are you making me learn it?" is a view that is shared by students of different sexes and cultures when they are subject to deficit stereotypes. Levinson, Foley, Weis and Holland (1996) claim that educated people are produced through culture (*The Cultural Production of the Educated Person*). Bloome offers a related perspective that builds upon their work, drawing attention to the ways in which language creates the social world. From this point of view, it is reasonable to speak of the 'discursive production of the educated person' (Bloome, personal communication, July, 2001). The prevalent discourse that constructs girls and other categories of students as "not good" at mathematics is a particular language that must surely have played a part in the under-representation of girls and women in mathematical competitions, courses, and professions. We can only speculate as to the ways the world would be different if researchers had focused on learning environments when they attempted to identify sources of inequalities. However, we can learn from the past and position research analyses in different ways. In 1981, Fennema raised this issue in an important article that sounded a cautionary note to equity researchers about the ways our work might be used, and the responsibility we bear for consideration of the ways it may be published. As a specific example she considered the media reports claiming that girls are genetically inferior to boys in mathematics that were based on the research interpretations of Benbow and Stanley (1980). Fennema pointed to the ways in which Benbow and Stanley's interpretations of their data *constructed* the idea of genetic difference, an observation that is important in its own right. In addition, she raised a general question that continues to be important to consider:

> Am I and others who are deeply concerned with helping women achieve equity, as well as Julian Stanley, helping females to achieve true equity in mathematics education? Or are we helping to perpetuate the myth that there are large and non-changeable sex-related differences in mathematics? Are we indeed creating a new mythology of female inadequacy in the learning of mathematics? (1981, p384)

It is important for all researchers to ask such questions of their work, but equity researchers, in particular, bear an enormous responsibility to consider the ways they are interpreting and framing their data, as well as the "mythologies" of inadequacy that may be constructed. Varenne and McDermott (1999) advocate a refocusing of the equity lens away from individuals and categories of people, and onto the systems which co-produce difference. The re-focusing that they suggest will involve departing from the essentialism of categories evident in claims that girls are 'maladaptive' or conceptually lacking, and committing to careful explorations of the circumstances that produce differences between groups. If we are serious about eradicating underachievement – not only for girls, but students of different racial, ethnic, cultural and socio-economic groups, then it must surely be time for ideas of intrinsic inferiority to be displaced. This shift may be a simple but powerful analytic resource in this endeavor.

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