Gender and Mathematics Education: Lessons from Pakistan

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This paper reports from a large scale action research study[1] on gender issues emerging in the context of mathematics education when teachers implement a new curriculum for improving gender equity in science and mathematics classrooms, and from field experiences when teacher educators promote gender equity teaching in mathematics.

Context and Background

Pakistan is a highly gender segregated society with strongly defined gender roles and responsibilities. Findings show that, teachers' beliefs and practices about learning and learners of mathematics are deeply rooted in wider sociological beliefs and practices about the role of men and women in society generally. The study has strong implications for policy and practice in mathematics teaching and teacher education.

Pakistan takes explicit account of gender in providing access to and administration of schooling. It divides schools into those with male students with male teachers, female students with female teachers and coeducational schools with male and female students and teachers. Typically, secondary schools in Pakistan are single sex schools. Parents prefer to send their girls to a single sex school. In case some private schools offer co-education at secondary levels, boys and girls usually sit in separate sections of the same class (Halai, Rizvi & Rodrigues, 2007).

A highly quoted, and ground-breaking national survey of schools (grades 4 and 5) in Pakistan studied if this use of gender made any difference to the achievement of male and female students in mathematics and science (Warick & Reimers, 1995; Warick & Jatoi, 1994). It was found that students of male teachers had significantly higher achievement scores in mathematics than students of female teachers in the same grades. However, the study went on to examine and provide explanations for this finding. In contrast to student gender it was found that teacher gender explained ten times more regarding student differences in their mathematical achievement. The study concluded that rural elementary schools are the main source of gender gap in mathematics achievement. Their most critical deficiency was in the inability of rural schools for female students to retain women teachers with adequate training in mathematics, and higher average level of education for male teachers than for female teachers (p.70-72). While this study is somewhat dated, the findings are still relevant. For example, reports persist of a bias in mathematics curriculum, textbooks and teacher education in favor of boys with strong implications for equitable learning opportunities for boys and girls in mathematics classrooms (Halai, 2006, Mukhtar, 2004).

The collaborative action research was undertaken with teachers from a highly disadvantaged rural district in the southern province of Sind[2]. It is a four year project (1st January

[1] Implementing Curriculum Change (science & mathematics) for Reducing Poverty and Improving Gender Equity in Disadvantaged Settings. Bristol University UK. Funded by DFID www.EdQual.org

[2] Pakistan is a federation with four provinces i.e. Punjab, Sindh, Baluchistan and North West Frontier Province (NWFP); federally administered areas, Azad Jammu and Kashmir, and the federal capital Islamabad. Sindh and Baluchistan include some of the most poverty stricken regions in the country.

2006-August 2010) and the first phase is complete. A purpose of the research is to study the process of implementation of the new mathematics curriculum for improved gender equity. Research process involves working closely with teachers to interpret the curriculum, and implement it through a gender equity pedagogy and develop contextually rooted responses to gender issues in mathematics classrooms. Data includes classroom observations, interviews with students, teachers and other stakeholders, student school examination results and samples of classroom work (for details see www.EdQual.org).

In accordance with the purpose of the research project participants were teachers from high/higher secondary schools in disadvantaged settings. Selection of the districts was made on the basis of "District Education Index (DEI)" developed by the Social Policy Development Centre as part of a major survey on the state of education in Pakistan (SPDC, 2002-03). Thatta and Tharparkar were at the bottom quintile amongst all districts in Sindh on the basis of the DEI. Between Tharparkar and Thatta, it was decided to conduct the research in schools in District Thatta as it would be possible to make the school visits in a day when travelling from Karachi where the research team was based, thus reducing the visit costs. From the nine *Talukas* (sub district unit) of Thatta *Mirpur Sakro* was selected as it is among the most poverty ridden talukas in the district and is convenient to travel to and from Karachi. More significantly it was important to identify schools within a geographical or administrative cluster because collaborative action research process takes strength from building collaborative networks in the community so that synergies maybe built. There were sixteen high/higher secondary government schools in Taluka Mirpur Sakro. Primary participants of the project were a total of twenty teachers, including ten women and ten male teachers. Secondary participants were about eighty teachers from all the sixteen schools and district education officers from Thatta.

Additionally, I have a wide experience of teaching and learning of mathematics and of mathematics teacher education in classrooms in Pakistan. Hence, the paper also draws on my wide experience of teaching mathematics teachers who attended Certificate, Advanced Diploma and Masters level methods course in mathematics. These courses were offered by the Aga Khan University Institute for Educational Development (AKU-IED). This institute was established in early 1994. Certain key features that make the AKU-IED courses innovative, at least in the region, include a focus on reflective practice through strategies such as action research and maintaining a reflective journal; field based nature of the courses offered, so that in-service teachers are sponsored by schools and are expected to return to their schools and implement their learning from the course work. Typically, participants in these courses and those in the action research project are expected to undertake analysis of science and mathematics text books from a gender perspective and lead or attend seminar/s on gender issues in mathematics and prepare gender inclusive curriculum materials. For example, usually the problems pertaining to the topic of area include contexts using sports fields or garden plots. In the course at AKU-IED teachers would prepare tasks on area and perimeter using contexts of "duppatta embellishment" i.e. embellishing a duppatta with embroidery all over (requires calculating the area) or embellishing with lace all around the edges of the duppatta (hence calculating the perimeter). Similarly, for ratios and proportions worksheets are prepared involving mixtures of Rooh Afza and water in different quantities. These examples were significantly different because they brought to fore contexts, which are strongly women's domains. As part of my teaching I carried a survey entitled "Boys are better mathematicians". I asked the class to respond to the three items 1, 2, and 3, given below. This cohort comprised 80% women and 20% men. They were mid career teachers with an average experience of 5-7 years.

1. Describe a brilliant mathematician. You may if you wish to, draw a picture of a top mathematician.
2. Boys are better mathematicians! Do you agree? Why? Why not?
3. Is teaching and learning of mathematics different for boys as compared to girls? How is this different and why is it so?

Employing the principles of action research, systematic ongoing analysis was undertaken of the reflective journal, interview transcripts and field notes. In addition focus grouped discussion with teachers were also recorded and analysed for identifying emerging issues and questions.

Findings and Discussion

Responses to items 1, 2, and 3 noted above showed that teachers had addressed items 2 and 3 in some depth but they had either not addressed item 1 or given very brief monosyllabic descriptions of a brilliant mathematician. Mostly a brilliant mathematician was characterised as a "good logical thinker". None of them had exercised the option to draw a picture of a brilliant mathematician. It is likely that teachers found items 2 and 3 closely linked to their experience of teaching and therefore addressed them.

Findings from teachers' responses to the items above and analysis of interviews revealed that teachers believe that

teaching boys is different from teaching girls. But, the reason for difference in teaching is ascribed to boys being intelligent and asking deep questions and girls being hard working, paying attention, and trying to learn not asking questions. Boys are naughty because they are interested in a lot of activities and have a lot of energy, while girls are shy, well behaved and easy to teach. Teachers appear to provide justification for boys' lack of attention and application by ascribing it to their involvement in other activities. These views about the expected and acceptable behaviour from boys and girls suggest that the girls' classroom would have a different ethos as compared to a boys' classroom. The difference would be in terms of the roles that the students play in the classroom and the relationship that they would have with their teacher – boys being more active, asking questions, and being encouraged to learn through motivational strategies. Girls on the other hand would be provided with rules which they are expected to follow. Their hard work and attentive nature would ensure that they participate in classroom work, irrespective of motivational strategies. Indeed, these different classroom ethos and relationships could mean that boys and girls learn different mathematics, even where curriculum content and materials are the same. Serious implications arise for mathematics teacher education as noted in this paper.

Findings also indicate that to create mathematics classrooms which are equitable on the lines of gender, key beliefs and perceptions of societal roles and expectations from boys and girls need to be challenged. For example, data shows that the perception of boys as better mathematicians are deeply and crucially linked to perception of gender roles in society.

> Yes, boys are better mathematicians because they think in (sic) deeply and try to find better solutions. To some extent I agree with this. And probably the reason for it is that Allah has made man superior to a woman. It is natural that from childhood they (boys) ask questions why, what, how. And comparatively girls from the beginning you explain to them and they accept it. They have curiosity but from the start that element of curiosity is bounded so that it stops. This is the reason that our experience tells us that boys learn better. (*teacher quotes*)

Hence, the notion that "Allah has prepared males as superior to females" or the view that "Girls are naturally shy and not prone to questioning" were evident in the responses that the teachers made, and have a strong role in how interactions in the mathematics classrooms are shaped. Hence, creating gender equity in mathematics is in fact changing these deep-rooted beliefs and perceptions of boys and girls, and of the roles that they play in society. Teacher education curriculum need to make these links explicit and bring them in the realm of discussions so that they may be problematised, challenged and modified.

Nature of mathematics knowledge as objective, fixed and rational would need to be challenged and replaced with a view of mathematics as socially constructed and culturally embedded. This view of mathematics would lead to the learners playing an active role in developing understanding through active engagement with the mathematical tasks and ideas.

Teachers tended to assume that with the "same national curriculum and prescribed textbooks" boys and girls had the same opportunities for mathematics learning provided they had access. However, micro analysis of classroom processes and interviews with teachers showed otherwise. In the single sex classrooms gender equity pedagogy required a nuanced and subtle approach to teaching, and creating conducive environment in the classroom. It required teachers to question their deep rooted assumptions about gender roles in society, perception of themselves as mathematics learners and its implications for positive or weak role models for mathematics learners. Teachers needed to pull back from the limited world of the classroom and contextualize their teaching in the broader social setting to recognize the gender disparity in the quality of mathematics teaching and develop a response to it.

Implications and Recommendations

These findings reported above have major implications and recommendations for teacher education curricula in mathematics. First teacher education curricula need to focus on teachers' life experiences within which are rooted their views and perceptions of gender. Hence, curriculum and courses which make a sharp distinction between personal and professional could result in false dichotomies with very little, if any, impact of the course work on changing teachers' belief and perceptions about gender (in this case) and mathematics teaching and learning. This bias towards boys was evident in the findings where an overwhelming majority still considered boys as better mathematicians. Teacher education curricula need to make these links explicit and bring them in the realm of discussions so that they may be problematised, challenged and modified.

Second, incorporating strategies and approaches to gender equity would need to problematise the nature of mathematics knowledge. For example, an implication of these views of knowledge residing with the experts is that it favours certain ways of knowing and certain forms of knowledge over others, so that in mathematics students are encouraged not to rely on their own experiences but to deny it and

to accept in its place the knowledge and experience of experts, thereby strengthening inequalities and inequities in the mathematics curriculum. This denial of ownership and personal knowledge are said to be antipathetic to the learning of girls and women (Povey, 1998).

Third, curriculum materials in mathematics are implicitly biased in favour of boys. Hence, teachers need to be critical consumers of mathematics curriculum materials including prescribed textbooks. They need to be aware of the gender bias of strategies to address it.

To conclude, research has shown that continued gender disparity in mathematics classrooms has meant that girls are denied the opportunity to engage in a positive manner with mathematics and to accrue the benefits from opportunities that advanced study of mathematics could yield. The issue is complex and requires further research and understanding. The complexity is due at least to two major issues. One, the nature of the discipline of mathematics and its dominant perceptions. Second, the gender roles and expectations that leads to different mathematics being learnt by boys and girls. In the first issue teacher education courses can take steps to enable teachers to modify their beliefs and practices pertaining to the nature of discipline. The second is a larger socio-cultural issue, requiring a big paradigm shift. Teacher education courses and curriculum developers would need to take into account a much broader socio-culturally embedded nature of classrooms and schools so that gender issues in mathematics classrooms could be recognized and addressed.

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