PATHWAYS IN MATHEMATICS TOWARDS EQUITY: A 25 YEAR JOURNEY

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ABSTRACT

A brief and selective overview of historical evidence of females' involvement in mathematics precedes a review of developments in research on gender and mathematics learning over the past 25 years. Evidence is presented that gender equity concerns have attracted considerable research attention by (mathematics) educators in many countries, and that over time the body of work on gender and mathematics education has increasingly reflected a greater diversity of inquiry methods used to examine and unpack critical factors. Research Reports presented at PME contain only limited evidence of these trends.

INTRODUCTION

Before turning to the main theme of this paper, developments in research on gender and mathematics learning since the founding of PME, it is appropriate to offer some brief, if inevitably selective, glimpses of females' involvement in mathematics in earlier times.

The first eminent woman mathematician

"It's true", wrote Woolfe (1996) in a popular novel, "that Hypatia, the ancient Greek mathematician, was the first eminent woman mathematician ... that anyone seems to know about" (p. 7). Readers are left in no doubt that her prowess in mathematics was both revered and feared.

> She had a huge following, and distinguished students came from Europe, Asia and Africa to hear her.... Cyril was fearful of her popularity and her religion, and incited a mob of fanatics, who dragged her to a church, murdered her with shells, and then burned her. This happened at the height of her fame, when she was 45. All her writings have been lost. (Woolfe, 1996, p. 7)

Hypatia's life, it appears, continues to fascinate those inside and outside the mathematics community. A brief biographical sketch, with reference to her mathematical excellence and her violent death, was recently included in the *Five things you didn't know about* regular column in a popular daily metropolitan newspaper (Hill-Douglas, 2001).

The Ladies Diary

A less spectacular, but more pervasive, example of females' involvement in mathematics is also worth mentioning. Some 300 years ago, in 1704 to be more precise, John Tipper launched the first almanack specifically aimed at women, under

the title " The *Ladies Dairy*[1] or the *Women's Almanack*[2]". Considered to be the prototype of the popular eighteenth century ladies' pocket books and diaries, it was itself highly successful, with an unbroken publication run until 1840 when it combined with the *Gentleman's Dairy* and continued to be published under the latter name for another 30 years.

The contents of The *Ladies Dairy* make fascinating reading, with hints about choosing a life partner, optimistic messages about the status of women, and pithy advertisements:

> Never marry a vicious man in hopes of reclaiming him afterwards; for those who are habituated to any manner of debauching or vice, if you think to reclaim by fair means, or by foul, you will find yourself fatally mistaken. (*The Ladies Diary*, 1704, p. 5)[3]

> The method that God observed in the creation, plainly shows women to be the most excellent of created beings. Which method of proceeding was from the less to the more noble beings, namely from the mineral to the vegetable; from thence to the animal kingdom; all of which being finished, he made men, and last of all women, in whom all the creation was perfected and its beauty complete. God having made women, ended his work, having nothing else more excellent to create… (*The Ladies Diary*, 1705, p. 15)

> Artificial teeth, set in so firm, as to eat with them, and so exact, as not to be distinguished from natural; they are not to be taken out at night, as is by some falsely suggested, but may be worn years together …. (They) are an ornament to the mouth and greatly help the speech. (*The Ladies Diary*, 1979, p. 48)

It is not clear why Tipper included two mathematics problems in the *Ladies Diary* of 1707. As master at Bablake school and a mathematician of considerable ability, he was certainly qualified to do so. At the same time, "the law, which the first contributors imposed on themselves, of not only proposing, but also answering all questions in rhyme, was not favourable to the development of Mathematical genius" (Leybourn, 1817, p. viii). Nevertheless, the inclusion of mathematics problems in all subsequent issues explains my interest in the *Ladies Dairy*.

Tipper's formula proved successful. "My almanac sold this year beyond mine and the company of Stationers' expectations, so that of 4000 which they printed, they had not one left by New Year's tide" (Ellis, 1843, p. 314), he wrote in a letter to a friend. Some years later, the then editor of the *Diary* wrote:

> I believe that the *Diary* has the good fortune to fall into a multitude of hands which mathematical books seldom or never would … [T]he fair

[1] Or *Ladies' Diary* in later issues
[2] I am indebted to Dr Teri Perl for her willingness to share her *Ladies Diary* materials with me
[3] The spelling in this and subsequent *Diary* extracts has been modernized

> sex may be encouraged to attempt mathematics and philosophical knowledge, they here see, that their sex have as clear judgements, a sprightly quick wit, a penetrating genius, and as discerning and sagacious faculties as ours, and to my knowledge do, and can, carry them thro' the most difficult problems. I have seen them solve, and am fully convinc'd, their works in the *Ladies Diary* are their own solutions and compositions….Foreigners would be amaz'd when I show them no less than 4 or 500 several letters from so many several women, with solutions geometrical, arithmetical, algebraical, astronomical and philosophical. (*The Ladies Diary*, Editorial, 1718)

Reference to the "discerning and sagacious faculties as ours" suggests that editor Beighton assumed that the *Diary* would be read by males. His words also foreshadow a theme to be mentioned later in the paper - the belief that for women to be the equal of males was high praise indeed.

The passage of time and the inadequacy of historical records make it difficult to quantify the full impact of the *Ladies Diary.* Yet, there is little doubt that the mathematical content of the *Ladies Diary* was taken seriously. In due course two substantial collections of "the useful and entertaining parts, both mathematical and poetical" of the *Diary* were published – the first by Charles Hutton (1775), professor of mathematics at the Royal Military Academy, and editor of the *Diary* from 1774 to 1818, the second by Thomas Leybourn (1817).

Problems, taken from the *Ladies Diary* of 1707, 1769, and 1814 respectively, and shown below, give some idea of the publication's mathematical content[4].

> If to my age there added be
> One half, one third, and three times three;
> Six score and ten the sum you'ld see,
> Pray find out what my age may be. (Question 2, *Ladies Diary*, 1707)

> Dear ladies, you with ease may find*
> A matchless hero's name,
> Who was beloved by mankind,
> And mounted up to fame:
> To serve his country boldly dar'd,
> Hot sulphur, smoke, and fire,
> And long campaigns' fatigue he shar'd,
> To conquer proud Monsieur.

* viz. From the equations

$$w + x + y + z = 52$$
$$wx + yz = 360$$
$$wz + xy = 280$$
$$wy + xz = 315,$$

[4] The selection is biased by concerns about space constraints. I have selected shorter rather than longer problems.

> where w, x, y, and z denote the places of the letters in the alphabet composing the gentleman's name. (Question 597, proposed by the frequent contributor Mr Tho. Sadler, *Ladies Diary*, 1969)
>
> If a globe, of 1½ foot diameter, be put to float in common water; required the area of the section at the surface of the water, when the specific gravity of the globe, to that of water, is as 3 to 5? (Question 1269, proposed by Mr Joseph Williams, of Canterbury, *Ladies Diary*, 1814)

Although the overwhelming majority of problems were posed and answered by males, there is evidence of females' mathematical activities scattered throughout issues of the *Ladies Diary*. The address to "Dear ladies" in the second of the problems reproduced is suggestive. Included among the seven correct answers for the third problem printed in the *Diary* was one from a *Miss* Susannah Jackson from *Mile End*.

The decision by a succession of editors to award a prize for the first correct solution received to selected mathematical problems enables at least partial tracing of those who engaged in mathematical problem solving. Perusal of other records shows that the surnames of many of the early female contributors matched those of well known male mathematicians or scientists. Thus having a brother or husband knowledgeable about, and sympathetic to, mathematics and scientific pursuits appeared a distinct advantage for females interested in mathematics. Significantly, contemporary research findings have revealed the benefits of a nurturing environment, access to needed materials, and support from critical others as facilitating achievement in mathematics. Perl's (1979) assertion that the solutions contributed by women were confined mainly to arithmetic or algebra problems is also consistent with females' preferences in mathematics reported in some contemporary research.

Those familiar with the life of Mary Somerville, the Scottish mathematician, have further indirect evidence of the importance of publications like the *Ladies Diary*. Mary was born in 1780. Her family attached far greater importance to the education of their sons than of their daughter. For her it was deemed sufficient to be taught to read the Bible by her mother, although when she was ten she was sent to a fashionable boarding school for 12 months. From there she emerged "with a taste for reading, some notion of simple arithmetic, a smattering of grammar and French, poor handwriting and abominable spelling" (Patterson, 1974. p. 270). Some years later, quite fortuitously, she came across an algebra problem which aroused her curiosity. In Mary's own words:

> At the end of the magazine, I read what appeared to me to be simply an arithmetical question, but on turning the page I was surprised to see strange looking lines mixed with letters, chiefly Xs and Ys, and asked "What is that"? "Oh", said (my) friend, "it's a kind of arithmetic; they call it Algebra; but I can tell you nothing about it"… On going home I

> thought I would look if any of our books could tell me what was meant by Algebra. (Somerville, 1873, p. 54)

Instead of encouraging this thirst for knowledge, her father forbade her studying mathematics. “We must put a stop to this”, Mary recounted him saying, “or we shall have Mary in a straightjacket”. Such beliefs also proved persistent. Decades later an American physiologist argued that “a young woman might learn algebra, but [he added] when the limited sum of energy flowed to the overwrought brain, it harmed the natural growth of ovaries” (Tyack & Hansot, 1988, p. 37). Nevertheless, Mary persevered with her mathematical studies. Her most effective mentor was the Scotsman William Wallace, then editor of the *Gentlemen’s Diary,* to which she sent a number of contributions. The close relationship between it and the *Ladies Diary* was fostered through cross references between the two publications. The eventual merging of the two publications has already been mentioned.

In Mary Somerville’s case the influence of a popular magazine that also contained mathematics problems has been recorded for posterity. It is tempting to speculate that many other intelligent women were stimulated to achieve mathematical literacy through the mathematics section of the *Ladies Diary.* That copies of the *Diary* found their way into Australian libraries may reflect the priorities of some of that country’s early settlers.

After this brief historical context, it is time to consider more recent trends, starting with the period approximating PME’s creation.

MATHEMATICS AND GENDER

Who Cares?

In a recent article, Lubienski and Bowen (2000) reported the results of their attempt to identify major areas of mathematics education research activity, including “the attention given to various equity groups and topics by the mathematics education research community” (p, 627). Their data source comprised 48 major national and international educational research journals accessible through ERIC and likely to include at least some mathematics education-related research. Eventually 3,000 articles were counted and categorized over the period selected: 1982 to 1998. The accuracy of their results, Lubienski and Bowen readily admitted, was heavily dependent on the accuracy of the ERIC descriptors and their categorization of those descriptors. Nevertheless, their findings offer a useful, if rough, measure of research interest among mathematics educators in gender issues.

According to their search, approximately 20 % of the articles (623 out of the total 3,011) concerned with mathematics education contained an equity theme, i.e., they contained a focus on gender, ethnicity, class, or disability. The majority of these, 323, were concerned with gender. In other words, some 10 % of all the articles identified contained gender as a factor of interest. Frequency of such articles varied with journal type. For example, in journals broadly classified as general educational and psychological, 15.2 % and 14.1 % articles of the articles respectively contained a

gender theme; for those grouped under US and international mathematics education journals the figures were 8.9 % and 7.7 % respectively. The thrust of these articles is the focus of the next section.

Identifying a "problem"[5]

During the 1970s, much research effort was directed at documenting gender differences in participation in mathematics courses and in performance on mathematical tasks and tests. A then timely "state of the art" summary read as follows:

> Are there sex differences in mathematics achievement? ... No significant differences between boys' and girls' mathematics achievement were found before boys and girls entered elementary school or during early elementary years. In upper elementary and early high school years significant differences were not always apparent. However, when significant differences did appear they were more apt to be in the boys' favor when higher-level cognitive tasks were being measured and in the girls' favor when lower-level cognitive tasks were being measured.... Is there "sexism" in mathematics education? If mathematics educators believe that there is a sex difference in learning mathematics (as was evidenced in the reviews cited) and have not attempted to help girls achieve at a similar level to boys, then this question must be answered in the affirmative. (Fennema, 1974, p. 137)

That concern about females' participation and performance in mathematics was not confined to the USA is evident from the excerpt below, taken from the report of the Victorian (Australia) Committee on Equal Opportunity in Schools:

> A large portion of mathematical ability resides in women and is potentially untapped. It has been a long-term aim of our educational system to develop individual talent, and the serious imbalance apparent in inculcating mathematics competence in men compared to women, demonstrates how far our achievement has fallen short of that ideal. (1977, p. 152)

Developments and explanations

The presentation below of the different phases in research on gender and mathematics education as sequential is simplistic and convenient rather than an accurate chronological representation. Trends described in earlier time spans have persisted in later research work; elements of those highlighted in the discussion of later years could be gleaned in earlier work.

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[5] The contents of this and following sections were shaped by collaborations and discussions with many colleagues. Of these, I wish to single out Elizabeth Fennema and Helen Forgasz as being particularly influential.

Early trends

Documenting current performance and participation differences, exploring likely contributing factors, and assessing the effectiveness of selected intervention strategies succinctly described the scope of research and scholarly activities with a focus on gender and mathematics in the mid 1970s and much of the 1980s. Gender differences in mathematics learning were typically assumed to be the consequences of inadequate educational opportunities, social barriers, or biased instructional methods and materials. It was further assumed that the removal of school and curriculum barriers, and if necessary the resocialisation of females, would prove to be fruitful paths for achieving gender equity. Male (white and western) norms of performance, standards, participation levels, and approach to work were generally accepted uncritically as optimum and to be attained by all students. When failing to reach these, females were considered deficient, or to use a theme from Kaiser and Rogers (1985), perceived as *a problem in mathematics*. They were to be encouraged and helped to *assimilate*. This notion, helping females attain achievements equal to those of males was consistent with the tenets of *liberal feminism*.

The 1980s

The *assimilationist* and *deficit* model approaches proved persistent throughout the 1980s and continued to guide many of the intervention initiatives aimed at achieving gender equity. Levels of males' and females' participation and performance in mathematics subjects continued to be reported in research studies, but now more frequently with an attempt at analysis - perhaps in conjunction with an examination of government policies. At the same time, different voices were beginning to be heard, undoubtedly influenced by work developed in the broader research community. The themes fuelled by Gilligan's (1982) *In a different voice*, and the feminist critiques of the sciences and of the Western notions of knowledge were particularly powerful. What other factors might be contributing to gender differences in mathematics education? Should we accept, uncritically, the way in which mathematics was being taught and valued? Should young women strive to become like young men or should the formers' goals, ambitions, and values instead be celebrated? What, crucially, might differentiate between a single-sex and co-educational school or class environment? Should we aim for uniformity or 'can different be equal'? In which setting might mathematics be taught and learnt more effectively by males and females? Should we accept only those conditions and approaches favoured by males? Such questions led to interventions which attempted to make the contents of mathematics less alienating to females. Rather than expect them to aim for male norms, attempts were made to use females' experiences and interests to shape the mathematics taught and methods of instruction. Females were to be perceived as *central to mathematics* and *mathematics* as being *reconstructed* (Kaiser & Rogers, 1985).

The assumptions of the "women as central to mathematics" phase were not without danger. Attempts to focus on women with exceptional and rare mathematical talents

proved problematic. Some of these portrayals, it seemed, simply confirmed how difficult it was for an "ordinary" (female) student to become an "extraordinary" mathematician, what hardships needed to be endured, what challenges to be overcome, what prices to be paid? Programs which valued and nourished qualities and characteristics presumed to be exclusively female could be thought to imply, directly or indirectly, that these were innate to females and alienate those who did not possess them. This essentialism risked perpetuating traditional gender stereotypes rather than redressing gender inequities. Nevertheless, recognition that previously unchallenged assumptions, traditions, and cultural exclusivity needed to be examined and possibly redefined was overdue.

The more critical attempts to analyse and deconstruct explanations for gender differences in mathematics learning and the clearer recognition that different perspectives inevitably lead to differences in the ways in which the interventions aimed at challenging inequities were framed were noteworthy developments in the later years of the 1980s. The attempts to make females more *central to mathematics* and of exploring the *reconstruction of mathematics* soon accelerated and diversified. The assumptions of *liberal feminism* that discrimination and inequalities faced by females were the result of social practices and outdated laws were no longer deemed sufficient or necessary explanations. Instead, emphasis began to be placed on the pervasive power structures imposed by males for males. The acceptance of (white, western) male norms, the assumption that females aspire to these standards and modes of behaviours, and the presentation of a deficit model of womanhood in which girls and women are positioned as victims with deficit aims and desires were also challenged. Some researchers wished to settle for nothing less than making fundamental changes to society. Advocates of this approach, often classed as *radical feminists,* considered that the long term impact of traditional power relations between men and women more broadly, and in mathematics more specifically, could only be redressed through such means.

Further changes – beyond the 1980s

Attempts to explore the interaction between gender and other background variables - socio-economic status and cultural and ethnic affiliations, for example – have intensified in the past decade. The concerns of *social feminists* voiced in the community at large, that females from working class backgrounds are often particularly disadvantaged in the home, in the labour force, and in access to leisure pursuits, have also influenced research in mathematics education. The genuine efforts made to mirror as comprehensively as possible the complex web of factors - personal, situational, and social - which might shed light on issues of gender and mathematics are reflected in more complex research designs and in designs relying for their conception, execution, and data analysis on multiple research methods.

An interim summary

In brief, gender equity concerns have represented a significant item on the research agenda of (mathematics) educators in many countries - in highly technological

societies as well as developing nations. International comparisons, formal and informal, have highlighted the roles of class and culture. For a given society, the status of mathematics in the lives of females is invariably linked to their status in that society. Male norms, and acceptance of difference without value judgments, have been more likely to be challenged in countries with active and long standing concerns about equity issues. Collectively, the body of work on gender and mathematics education reflects an increasing diversity in the inquiry methods used to examine and unpack critical factors. More radical feminist perspectives are being adopted, females are less frequently considered as a homogeneous group, and scholarly evaluations of interventions are becoming more prevalent. At the same time there is a clearer recognition of the extent to which the personal beliefs and theoretical orientation of the researchers undertaking the work influence inclusion and exclusion of variables and modes of data gathering. No longer is it simplistically assumed that the planning, execution, reporting, and interpretation of research are value free.

It is difficult to quantify the extent to which perceptions about gender and mathematics learning have changed. A recent research study (Leder & Forgasz, 2000) provides one measure. A sample of approximately 860 students in coeducational high schools in Victoria, Australia, completed a questionnaire aimed at tapping gender stereotypes about aspects related to the learning of mathematics. For each of 30 statements students were asked to indicate whether they believed (1) the statement to be definitely more likely to be true for boys than girls, (2) probably more likely to be true for boys than girls, (3) there was no difference between boys and girls, (4) probably more likely to be true for girls than boys, or (5) definitely more likely to be true for girls than boys. The data obtained from administration of that questionnaire were compared with findings reported in previous relevant research (see Table 1).

Table 1. Predictions based on previous research and findings from the study (Italics bold)

	ITEM	Pred	***Find***		ITEM	Pred	***Find***
1	Maths is their favourite subject	M	***F***	16	Distract others from maths work	M	***M***
2	Think it is important to understand the work	F	***F***	17	Get wrong answers in maths	F	***M***
3	Are asked more questions by the maths teacher	M	***M***	18	Find maths easy	M	***F***
4	Give up when they find a maths problem too difficult	F	***M***	19	Parents think it is important for them to study maths	M	***nd***
5	Have to work hard to do well	F	***M***	20	Need more help in maths	F	***M***
6	Enjoy mathematics	M	***F***	21	Tease boys if they are	M	***M***

	ITEM	Pred	*Find*		ITEM	Pred	*Find*
					good at maths		
7	Care about doing well	M/F	***F***	22	Worry if they don't do well in maths	M/F	***F***
8	Think they did not work hard enough if don't do well	M	***F***	23	Are not good at maths	F	***M***
9	Parents would be disappointed if they don't do well	M	***F***	24	Like using computers to solve maths problems	M	***M***
10	Need maths to maximise employ opportunities	M	***M***	25	Teachers spend more time with them	M	***nd***
11	Like challenging maths problems	M	***nd***	26	Consider maths boring	F	***M***
12	Are encouraged to do well by the maths teacher	M	***nd***	27	Find maths difficult	F	***M***
13	Maths teacher thinks they will do well	M	***F***	28	Get on with their work in class	F	***F***
14	Think maths will be important in their adult life	M	***F***	29	Think maths is interesting	M	***F***
15	Expect to do well in maths	M	***F***	30	Tease girls if they are good at maths	M	***M***

There were only eight items, it can be seen from Table 1, for which the responses were consistent with previous findings. These items were largely related to the learning environment and to peers. For example, boys were still believed more likely to distract others from their work (Item 16) and to like using computers to solve problems (Item 24). Girls, there continued to be agreement, were more likely to get on with their work in class (item 28). In the past, boys were generally believed to have more natural ability for mathematics than girls, were considered to enjoy mathematics more, and to find it more interesting than did girls. Yet the more recent data revealed that, on average, students now consider boys more likely than girls to give up when they find a problem too challenging (Item 4), to find mathematics difficult (Items 27 & 18), and to need additional help (Item 20). Girls were considered more likely than boys to enjoy mathematics (Item 6) and find mathematics interesting (Item 29). Responses on so many items inconsistent with previous findings surely implies that changes have occurred over time in gendered perceptions related to mathematics education, that, in other words, the energy expended on documenting gender inequities and attempting to redress them have left

their mark. It is perhaps worth adding that the gendered perceptions captured by the questionnaires are fully consistent with interview data gathered in recent studies involving students from elementary school to university (Forgasz & Leder, 2001; Landvogt, Leder, & Forgasz, 1998).

A focus on gender and PME activities

Comparisons of research attention on mathematics and gender between the wider mathematics education and PME communities reveal an ambiguous picture. On the one hand, females have figured quite prominently in PME activities. Four of the ten presidents to date have been female (though the first four presidents were males). From the outset, females have been active presenters of Research Reports: females were sole or co-authors of more than one-third of the Research Reports presented at the third PME conference, for example.

Yet those leafing through *PME Proceedings* will observe a more subdued emphasis on research concerned with gender and mathematics among the PME community than within the mathematics education research community at large. This may be a reflection of the beliefs expressed by participants at the earliest PME conferences that issues of gender differences were considered irrelevant in their own countries[6].

Inspection of *PME Proceedings* soon reveals an inconsistency in the listings of Research Reports, with *Proceedings* editors clustering them by category in some years, but not in others. When clustering occurred, there was considerable variation in the number of articles listed under each heading. For example, the Research Reports delivered by the 70 presenters at PME2, and included in the 1978 *Proceedings,* were grouped into five themes: *The Acquisition of Mathematical Concepts, The Learning of Generalisation and Proof, Interpersonal Aspects of Communication, The Nature of Mathematical Thinking, a*nd *Intuitive and Reflection Processes in Mathematics.* The 1982 *Proceedings* were divided into 12 categories, with the number of entries ranging from nine (*Concept Formation*) to one (*Discovery Learning* and *Neurophysiology*); the 1993 *PME Proceedings* contained16 different categories, with entries ranging from eleven (*Epistemology, Metacognition, and Social Construction* and *Problem Solving*) to one (*Probability, Statistics, and Combinatorics*). These examples show that having few *Research Reports* in a particular category was no barrier to that topic being highlighted on the Contents pages. Yet even in years in which a number of Research Reports contained the words “sex” or “gender” in the title, inclusion of gender as a category heading was rare, with the 1984 *Proceedings* in which two papers were listed under the heading *Girls and Mathematics* a notable exception. Presumably, then, the interest for research into gender and mathematics exhibited by some PME participants was not necessarily shared by the editor(s) of the *PME Proceedings*. Greater attention to the key words provided by Research Report authors to describe the content of their paper might provide a more equitable listing in future.

[6] I am indebted to Alan Bishop for sharing with me his recollections about the early PME conferences.

As it stands, it is no easy task to trace how the topic of gender and mathematics has been explored in PME Research Reports.

PME and research on gender and mathematics

In the time and space available, it is impossible to give a comprehensive summary of all papers with a strong gender theme delivered at PME conferences. To summarise briefly and with no attempt at full coverage of Research Reports which included "gender" or "sex" in the title:

- Compared with other topics covered, gender issues have apparently been of limited interest to those presenting Research Reports at PME
- Sample details in the early papers rarely included the numbers of males and females involved in the research study, though this information was included in later reports
- Early papers in particular contained the "females are deficient" theme (e.g., Barboza, 1984[7])
- Others contained the "male norms are the standard measure for comparison" theme (e.g., Collis & Taplin, 1984; Leder, 1986; Mukuni, 1987; Kuyper & Otten, 1989, Visser 1988)
- The variety and complexity of the methodologies and instruments used for data collection increased with time, in line with the research reported in other settings and vehicles (e.g., Underwood, 1992)
- Early findings were increasingly revisited and previous assertions about the effect of gender on mathematics learning challenged (e.g., Forgasz, Leder & Gardner, 1996; Forgasz & Leder, 2000 – gender stereotyping of mathematics; George, 1999 and Gorgorió, 1992 – gender differences in visual representation; Pehkonen, 2000 – mathematical reasoning)

As indicated earlier, this list is most aptly described as indicative of the scope of research reported at PME, and does not aim to be exhaustive. Yet it prompts an inevitable question. To judge from the contents of the Research Reports included in Conference Proceedings, would those hoping to hear cutting edge research - whether experimental or theoretical, qualitative or quantitative – be more likely to be satisfied or disappointed by the fare at PME conferences? Where are the reports of research studies, detailed in other venues, in which more radical feminist perspectives are being adopted, females are less frequently considered as a homogeneous group, and fine grained rather than collective data are presented? Where are the reports of scholarly evaluations of large scale interventions? Or detailed case studies which focus on individual rather than group differences? Or reflective accounts of the impact of the personal beliefs and theoretical orientation of the researchers undertaking the research on design of the study, data gathering decisions, choice of instrumentation? From personal experience I know that these issues are of interest to members of PME and are discussed within venues such as Discussion and Project

[7] Papers which appeared in *PME Proceedings* are not cited separately in the reference list

Groups - group activities which have scant permanent or written records. It does not take long to decide that the format adopted for PME written Research Reports, and let me add a format carefully and sensibly selected for many good reasons, favours the reporting of studies with certain data and research designs but discourages the reporting of others. Tracing the debate on gender and mathematics within the Proceedings of PME conferences has been an instructive and, for me, provocative exercise.

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