The Construction of Personal Theory on Gender and Mathematics: Nine Case Studies of Women Primary Teacher Trainees

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This paper discusses the experiences of nine women in their high school mathematics and their personal theories on gender and mathematics. Interviews with the women showed that while their performance was above average up until Year 10, only one student completed higher mathematics. In general, support from mathematics teachers was seen as very negative. Further, their personal theories on gender and mathematics are the result of interaction between their own experiences and the research knowledge they encountered at university during their completion of a teacher training course.

There are encouraging signs that gender differences in achievement in mathematics are now less significant than earlier research has shown (see Burton, 1986, 1990; Fennema & Leder, 1990; Leder, 1992; Leder & Forgasz, 1992). There does remain however, some evidence for differences in attitudes toward mathematics as expressed by females and males beyond the primary schools. For instance, females tend to underestimate their ability in mathematics and attribute it to hard work rather than to natural ability. Even in cases where females attitudes toward the subject is not lower than males, they tend to opt out of higher level mathematics sooner. Also the impact of early childhood and primary schooling on how girls and women develop negative attitudes toward mathematics has been well documented (Clark, 1990; Kenway & Willis, 1993; Large, 1993). Although several factors may contribute to the development of attitudes toward school subjects, the role of the teacher is quite significant. Recent reports (Cobbin, 1995) have argued that many trainee teachers remain weak in mathematics and science and have little interest in teaching the subjects. This is especially significant for women as they continue to dominate the ranks of early childhood and primary training and teaching (Aspinal & Drummond, 1989; Cobbin, 1995). Furthermore, Southwell and Khamis (1992) hypothesised that "if pre-service primary teachers hold beliefs to the effect that mathematics is a very difficult subject, that they are not good mathematicians and that mathematics has limited appeal and use, their teaching will reflect these beliefs and each new generation of learners will be locked into similar beliefs and negative attitudes" (p. 497). Clark (1990) reported that many Australian women went into primary teaching because they saw themselves as "not good at mathematics." Other reasons women cited for taking up primary teaching included family pressure on them to do so, the preference they have in working with younger children, lack of other options and a fear that they would fail in non-traditional fields of work and study.

Previous research had not examined primary teachers' views on gender issues in mathematics education. This paper investigates the construction of personal theories on gender issues of a group of graduating women teacher trainees as a function of the women's experiences in school mathematics. Firstly, the achievement, confidence and participation of these women teachers in high school mathematics will be examined. Secondly, the opinions of these women on the support that they obtained in their school studies will be discussed. Thirdly, the paper outlines the personal theories of these women on gender issues. Fourthly, the relationship of the personal theories and the women's experiences in mathematics will be examined.

The Study

The present study is the first stage of a longitudinal action research project (Atweh, Kym, Burnett, 1996) conducted with a group of women teachers in transition from a four year university course into the first year of teaching practice. The project investigates the needs of these women to make primary mathematics teaching more inclusive. The study commenced in 1996 with a survey of final year women students from a Bachelor of Education course at a university and was followed through with an interview with a

selected sample. Atweh, Kym and Burnett have reported on the survey results and this paper reports on the interviews conducted with the women.

In 1996 about 100 women students undertaking a final year mathematics education unit were given a questionnaire on their attitudes and beliefs about mathematics and mathematics education. The women were invited to participate in a longitudinal study. About 13 women volunteered, only 9 made themselves available for the interviews. Semi-structured interviews were conducted to investigate in depth the previous experiences of this group of women in both school and university mathematics classes, their expectations and concerns about teaching mathematics and their views on gender issues. These interviews were audio taped and transcribed. They were conducted at the university and were between 1-2 hours each.

In Queensland, most high schools begin steaming mathematics in Year 10 where students choose from Ordinary Mathematics - the lower non academic stream - and Advanced Mathematics. At Years 11 and 12, students may take Mathematics and Society, Maths I or Maths I and II.

Findings

Achievement, Confidence and Participation

Four of the nine women interviewed described their mathematics performance up to Year 10 as "top of the class" (Fran, Mary, Sandra, and Nellie). However none of them did higher level mathematics in Years 11 and 12. Two of the women attempted such a course but then dropped after 1 or 2 semesters. Mary, received High Achievement in Advanced Mathematics in Year 10, yet she always felt that she lacked the understanding and meaning behind the content learnt. She saw no point in learning mathematics. She attempted Maths I to keep her options open for university entry. When she realised that mathematics was not required for entry into her chosen course, she dropped mathematics all together rather than doing the lower stream mathematics ("vegie maths" she call it) or risk failing Maths I. However, she indicated that she feels quite confident in doing and using mathematics in everyday life situations.

Similar experiences were related by Sandra. She was at the highest level of performance throughout primary school and lower secondary school. In Year 11 she choose Maths I. She reported that she "was always asking the teachers 'why are we doing this and where would we use it'" She stated that none of the teachers could answer these questions - "I just didn't see the point in doing it, I just couldn't understand it and it was just too difficult - so [I dropped it]".

Nellie did not attempt Maths I. Although she topped the class in Mathematics and Society, she described herself as "not a mathematical person". She indicated that she feels more confident in low level mathematics and feels quite confident in using mathematics in everyday life. Similarly, Fran belonged to a group of three top achieving students (herself and 2 male students) that always finished class work early and were given additional advanced work by the teacher. Algebra "scared" her because it took her longer to understand, it did not have any apparent application and was a source of failure for many of her friends. Considering her career aspirations, she decided she did not wish to enrol in higher mathematics in Years 11 and 12. Her mathematics teacher in Year 9 made several attempts to encouraged her to change her mind. She considered his views but decided against the advice. Failing to convinced her, he rang her parents and requested their support. Fran argued that she did not need higher mathematics, she enjoyed Mathematics and Society and she was a "little scared" of the higher mathematics.

Two other students had achieved above average up to Year 10 (Jane and Jackie). Jane was the only women in the sample to have completed Maths I in Years 11 and 12. She reported that she enjoyed mathematics when its relevance or application was obvious. She "switched off mathematics" at Year 11 when she encountered higher algebra (this she calls "scientific mathematics" e.g. trigonometry). She realised she could have achieved better with extra work and rote learnt the content, but she did not feel that this would have given her the understanding and meaning she lacked. She enjoyed mathematics in accounting where she could see its logical structure and obvious use. She had a positive self image of her ability up until Year 10. When she joined the higher course of Maths I, her confidence and self image declined when she compared her achievement with that of

the more able students. Similar experience was related by Jackie who felt that she "was above average up to Year 9". Being placed with the top stream of advanced mathematics at Year 10 she felt "dumb" compared to other students. Jackie also suffered from exam failure anxiety. She declared: "In Year 10 I failed one test, I cried - I could not handle it. I felt so sick of not being able to do it. I thought I put a lot of work into it". In Years 11 and 12 she did Mathematics and Society.

Louise also described herself above average up to Year 10. She felt confident in using mathematics and problem solving in everyday life yet she felt anxious if someone asked her to do something in her head. (Public anxiety about lack of mathematics ability identified by a few of the respondents.) For the same reason she felt low confidence in teaching mathematics - "you can not afford making a mistake with the children, because "once they learnt it wrongly, is very difficult to unlearn it." She developed low expectations of her ability for success in mathematics - "I just want to pass". She did Mathematics in Society because she "was not good enough to go into higher mathematics - I did it because it was compulsory."

Pam and Kym had difficulties in mathematics that can be traced to the primary school. Pam had an eye problem in the early primary school that delayed her school achievement. She developed low self esteem in her primary and secondary years and a self image of "lower than average in mathematics" and "not very competitive". Having studied ordinary mathematical at Year 10, she was locked into the lower stream mathematics. She is very confident now that she could have handled Maths I at Years 11 and 12. Sometimes she wished she "could do it all over again" to show that she could pass Maths I! She indicated that she was seriously considering it. Similarly, Kym's problems in learning mathematics started early. She recalls the difficulty she had in learning number facts. To cope with her lack of understanding, she often resorted to "learning thing by heart without understanding". She developed a good sense of what was important on the exam and "cramming it" and "somewhat manage to get through". Because she was good in other subjects her difficulty in mathematics was not noticed, or if noticed not taken as a serious problem by teachers nor family. Similar pattern occurred at university; for instance, because she was getting 7's in her subjects, when she complained to a lecturer that she was not really good in mathematics, he simply affirmed that she was "a good student - a really good student".

Support Received

Kym grew up in a rural area where little help was available. She realised she had difficulties in mathematics in the primary school. While at some time she may have felt "dumb" about her lack of ability she now says that she does not blame herself. She harbours some anger against the teachers who "did not really pick on the fact that I was having trouble". With her father being away most of the time, and request for help form her mother often lead to "screaming matches", Kym ended up in a situation of not seeking help at all. She often tried hard to conceal her lack of ability and understanding. "I always had really neat work, ... so that it looked like I was understanding it". She stated that patience from her parents would have been beneficial for her to overcome her difficulties. She tried to ask for help from teachers, only to be given more examples to do on her own.

This pattern of concealing difficulties in learning mathematics from others is not isolated in this group. Mary had decided she did not want to do lower level mathematics at Years 11 and 12. She felt she did not receive any support from her parents. She described her father as someone who "really does not know what is going on in my subjects". Her mother supported her decision to keep her options open by attempting the higher level mathematics. Her parents did provide a computer tutoring package, Promath, and a private tutor. In school, Mary did not want her teachers to know about her problems. She tried to hide her difficulties - "did not want any attention". She described her anxiety about "not knowing what to ask for" when she did not understand mathematics. Talking to a mathematics teacher about her low performance during the first term in Year 11, and about her plans for the future, he said "well you can keep going [in the subject] if you want to" but he made it clear that "he didn't really see the point" of her doing so. This was not seen as negative by Mary. She described her feeling as: "I was like, Hallelujah!" It was the ticket to her freedom from mathematics!

Louise and Sandra had generally supportive parents. Yet they both reported regrettable lack of support from teachers in schools. Sandra described her mathematics teachers as people who "do not care and they were distant". Louise said they "just give you a lesson and its up to you to understand it or not". They both mentioned other teachers, such as English and humanities, who were normally much more supportive than any of their mathematics teachers.

Two more students complained about negative effects of lack of support from mathematics teachers. Pam indicated that she tried to enrol in a higher mathematics in Year 10. She did receive some support from her parents on that decision. Her parents "did not push", but then she added "I am the type of a person who if I was pushed I would have done it". However, support from the teacher at school was minimal. One teacher in particular "was negative all the time and her attitudes was 'if you can not handle it you should drop back [to a lower mathematics class]'". Pam was quick to add that "I hold no grudges. That is why I am interested in this project - when I become a teacher, I want to do the best and encourage [everybody to do well in the subject]". During her high school, one teacher showed special interest in Pam and sought the help of a science teacher. Her performance improved considerably, until the assisting teacher left the school and things went "back to the same old problem".

Jane also received little support from her teachers. When asked whether anyone in high school encouraged her to do well in mathematics she said:

> *No, I wouldn't think so. The teachers probably discouraged me more than anything because it was the one's who were always getting it right they were getting the attention and the one's that were falling behind it just didn't matter. Happened more in senior grades, like it was your fault, if you weren't doing well you hadn't done your homework so it's out of their hands.*

Jackie attributed the lack of teacher support towards her as a gender issue. The first secondary school she attended was an all girls' school where she felt she received considerable support. Moving to a mixed, and larger school in Year 11 and 12, made it difficult for the "teachers to know you - I felt in the background." Perhaps what made it more difficult was that the new school was all boys until Year 10 and then mixed at 11 and 12.

Only two of the interviewees indicated positive support from teachers in high school. Nellie was grateful for her teachers efforts to correct errors and look closely at her work. Fran talked about having a good supportive, yet not pushy family. At one stage of the interview she said "it is definitely the family influence that's where I am". Likewise, the support of the teacher in Year 9 reported above, was also given by Fran as an example of teachers encouraging girls to do well in and study more mathematics.

Personal Theories of Gender and Mathematics

Three of the women interviewed indicated that their experience did not match what they read at university about gender differences in mathematics. Sandra disagreed with emphasis from research findings that, "more attention is given to boys" in mathematics classes. In her experience she "had not observed this at all". She asserted that mathematics is compulsory up to grade 10 and un-streamed until grade 9. Although she did not do higher mathematics she thought that the gender distribution was about equal. She added "from my experience the people who got extra help were the ones who asked for it; I found that it was mostly girls who asked for help and they got it." Sandra does not refute all research findings. In fact when she was asked about evidence that even successful girls tend to move away from mathematics she said, "I mean it's been proven so I accept it, but I really don't know why they have moved away from it". In her view, to avoid this drainage away from mathematics, teachers can encourage girls more and commence career awareness at the end of primary school.

Mary also questioned common assumptions that are derived from research, "[I]n all my classes there was a balance, so I really didn't see that there was a gender inequity happening - except in English where the teacher related differently to the female and male students". When asked about the reasons why girls dropped out of mathematics more than boys, she presented various hypotheses: "Maybe its still that stereotypical thing that there are the jobs that women don't need a mathematics basis for them; ... maybe they

find it too mentally demanding and they cant handle it or something; ... [or maybe] they do not see why they need it". Her answer to the question of how to encourage girls to stay in mathematics longer, brought a lengthy, and very illuminative response that is worth quoting at length. The underlined phrases will be used in the analysis below:

> *I don't know I really think ... [dropping out of mathematics is] a personal thing. If you don't, I don't know, maybe I'm not looking at the wider picture, it was like an individual thing with me because even though I knew that I was doing the stereotypical thing of going into teaching like "good girls" do, [i.e.] it's a female oriented thing, and doing the humanity thing at uni, but I liked them. Maybe, you know, you have to say "but what influenced you to like them and not the other", and it's like I, I didn't see myself as being worked against in the feminist stereotypical thing. But then again, that's just because I'm not aware of it doesn't mean it's not happening, but I never sort of felt any pressure that I should do it or I shouldn't do it. It was sort of just never there with me. I don't know whether it's there with other people. I don't know, sometimes I think it's being over rated that just girls are not going into maths. ... But then again I was at an all girl's school from grade eight to ten anyway, so I didn't see the difference in numbers going into maths. Like they were all girls there anyway so that's probably just based on my own personal experience. ... Maybe girls don't want to be seen as being bright or especially girls in the more low socio-economic areas that want to be seen, because they've been urged into the direction that their life is going, to be like their parent's life....*

It is interesting to note the following tensions and forces in this response. First, there was the tension between the personal experiences ("it was an individual thing with me") and the generalisations from research findings ("maybe I'm not looking at the big picture"). Similarly, there was an obvious tension between personal freedom in choices ("I liked them") and societal conditioning in making selections ("I was doing the stereotype thing"). There is also a tension between the obvious blatant coercion ("I did not see myself as being worked against") and the more subtle influencing ("Because I'm not aware of it does not mean its not happening"). There was also the tendency of making research findings apply to the "other" ("especially girls in the more low socio-economic areas").

Similarly there was some kind of ambivalence in Fran personal theory on gender and mathematics. She asserted that gender is not a factor of success in mathematics. Success in mathematics is a personal decision. She accepted the possibility that there may be cases where boys were encouraged more to do higher mathematics, but "I have never came across it". Likewise she has "never seen teacher favouring boys" in mathematics classes. Her experience with the male teacher who encouraged her to study higher mathematics at grade 11 related above was presented as a counter-example to what she has "been taught at the university". She exaggerated the research findings by portraying a picture in which the girls are "just being scared off it [i.e. mathematics] altogether". However, Fran conceded that some high school students may miss out upon role models and hence have no incentive to do mathematics as a result of male domination of the numbers of mathematics teachers. Further, she believed that being aware of the issues of gender and mathematics is important for primary school teachers in order to avoid falling into practices that may alienate or discriminate against the girls.

Other students did not see a conflict between their experience and research findings portrayed to them during their university course. Nellie indicated that she went to a girls school. Although conceding the school may differ in their assessment, she did not think that the school had a high focus on mathematics. It was "rather acceptable for the girls just to go to Mathematics and Society". She related the experiences of brother who attended a mixed school where "the attitude there is to just do the mathematics and see where it lead you". As for the reasons why girls drop out of mathematics, she present two possibilities: boys' domination in the classroom or that "girls find mathematics too rigid to express their emotions so they choose language subjects".

Louise asserted that gender had a limited effect on achievement in mathematics. She held the view that "it is proven that men are better in spatial ability than women. I do

not know if it is the educational system, men and women are totally different and they think differently. It could be biological". However, teachers can do something about success and participation of girls by making mathematics more "fun or interesting" and do more to encourage girls to succeed.

Girls' participation in higher mathematics, according to Jane, depended upon whether the girls could see mathematics as an important subject which in turn depended upon their career aspirations and values in life. Girls self confidence is important for their success and participation which in turn is influenced by attitudes of others in the classroom.

Pam also went to an all girls' school which placed special emphasis on mathematics and science. She recalled the example of her brother who has a better understanding in mathematics, hypothesising that his involvement in manual arts may have increased his ability to understand mathematics. She pointed out the "gender bias" in her household in terms of division of labour between the females and males.

Jackie also sighted examples of males within her family who have been able to achieve good results in mathematics. She asserted that:

> *as a girl in classroom you tend to be forgotten unless you are outspoken. You have to demand assistance and attention. Behaviour problems form the boys imply that they do not get much attention. ... When I was in a single sex school I felt much more confident - even though we had bad behaving girls, it was different - they cared more. The mixed school had a better reputation so I went to it. I would probably have done much better if I went to single sex school at 11 and 12.*

Finally, Kym points out the "stereotype [sic] view that boys should be better at maths and science and girls should be better at English and arts and that sort of thing. If the teacher holds these kinds of views then it can become a self fulfilling prophecy". Female teachers are not immuned from such stereotypes, according to Kym. Further, this stereotyping can also come from the home. She recalls her "mum always used to say "oh don't worry I wasn't very good at maths either".

Conclusion

Undoubtedly, the case studies reported above show a wide range of experiences, attitudes, beliefs and expectations of this particular group of women as they approach their first year of teaching. In the midst of this diversity, the following patters may be identified. The majority of the women saw themselves as high achievers, or above average, up until Year 10. Yet, almost none of them attempted higher mathematics at the senior school. There was also strong evidence that the majority found teacher support to be minimal, if not of a negative effect.

For someone who is familiar with the research on the experiences of women in mathematics, these patterns are not surprising. What is of interest here are the views of the women on gender issues. The three women (Sandra, Mary and Fran) who questioned research evidence based on their own experiences were high achievers in school mathematics. The choices that they made to drop mathematics seemed to them to be based on individual choice. Arguably, they failed to see the pattern of dropping out of mathematics as more relevant to women in general. There was also evidence that the other women who have seen their experiences as consistent with research findings also were influenced by their own experiences. For example, Kym has developed difficulties in mathematics early in her schooling. As an adult she had some anger at her parents and teachers for not taking action about these difficulties. One reason she raised for not identifying the problem, was that she "was good in other subjects". This lack of action on her difficulties by the others is consistent with a possible belief on their part that girls are not supposed to be good in mathematics and/or do not need as much mathematics. This is consistent with Kym's belief that teachers stereotypes may become self-fulfilling prophecies. These findings have implications for teacher preparation courses. It may be necessary to discuss research findings on gender in the light of the students' own experiences in studying mathematics. The sharing of personal stories and aspirations may be as beneficial in constructing more effective personal theories of gender and mathematics.

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