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## ABSTRACT

The effects that peer interactions in an adult mathematics classroom have on the children of women returning to study mathematics were explored in a case study of seven Australian mothers who had school-aged children and who had returned to study mathematics in Australia's technical and further education sector. During the 12-month study, the mothers were interviewed twice and family follow-up interviews were conducted. Five of the women mentioned being able to assist their children in school as one of their specific reasons for returning to study. During the course of the women's experiences in a formal classroom where peer interaction was encouraged, the women developed a deepened appreciation for the value of their peers' different perspectives as they assisted in the women's developing understanding. This shift, in turn, affected the relationships existing between the women and their children. Evidence of emergent dialogues of mathematical inquiry between the women and their children was found. By applying their new knowledge in dialogues with their children in their homes, the women were affirmed and further stimulated in their new learning mode. The study provides evidence that the private world of the parent-child relationship deserves greater attention for its potential contribution to constructing new mathematical knowledge. (Contains 34 references.) (MN)

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**Peer-interactions in the adult mathematics classroom and the flow-on effect to the children of women returning to study mathematics**

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Paper presented at the Annual meeting of the American Education Research Association, New Orleans, April 1-8, 2002<sup>1</sup>

ABSTRACT

The further education sector in Australia plays a crucial role in the ongoing learning for adults, particularly for those who have been unsuccessful in the secondary school system. This paper draws on case study data of women with school-aged children who had returned to study mathematics in this sector, most of whom, though not all, had poor experiences with studying mathematics at school. Apart from financial considerations, personal fulfillment, and wanting to develop a career, many of these women reported a hope that by returning to study this would enable them to assist their school-aged children academically. In, particular, their aim was to help their children avoid suffering the learning difficulties that they had endured during their schooling. This hope is well founded for previous studies have noted educational benefits for the children of women returning to study.

In this paper I explore this process drawing on both the women and their children's experiences. I identify shifts in the women's epistemological orientation towards mathematical meaning making through their experience of an interactive adult classroom learning environment; and how this in turn, impacts upon the relationships between the women and their children. Evidence of emergent dialogues of mathematical inquiry between the women and their children is presented which support the development of the women's confidence in the process of applying and integrating the new learning together. Data are drawn from two interviews and classroom observations of seven studying mothers over a 12-month period and follow-up family interviews.

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<sup>1</sup> Paper based on chapter in forthcoming book; *Which way Social Justice in Mathematics Education?* Leone Burton (ed), 2003.

## INTRODUCTION

In Australia, the further education sector is crucial in the ongoing learning for adults, particularly for those from lower socio-economic backgrounds and for women in the 30-40 years who were early school leavers. For those people who have been unsuccessful in the secondary school system, it generally provides a safe, friendly, and non-coercive learning environment (Teese Davies Polesel and O'Brien 1999). Historically, adult education has had a problematic status, viewed as the "poor cousin" of the school system (Newman 1979) where women have been viewed as the "invisible owners" but not directors of the sector (Tennant 1991). Pathways from the further education sector into the higher education system remain problematic in Australia as the extent to which adult education courses are recognised by universities varies widely (Teese et al. 1999). This is currently being addressed at the policy level with the aim of continuing to recognise the unique value of the sector in terms of its social transformational potential (Bradshaw 1999). The four key principles in this policy document are multiplicity, connectedness, critical intelligence and transformation, which resonate with aspects of the epistemological schemas of Baxter Magolda (1992), Belenky et al. (1986) which are used in this paper to examine the women's experiences and beliefs through an epistemological lens with respect to the learning of mathematics.

In this paper I describe a learning synergy that can occur between women and their children when the women return to study mathematics in the Victorian further education sector, Australia. These women were from educationally impoverished backgrounds and according to social theory were at risk of limiting their children's academic potential. It is well documented that children of middle-class parents generally do better at school than their working-class peers and 'social reproduction' theories are often used to describe this phenomenon that are based on the occupation, education and associated values and attitudes acquired by the parents-to-be (Burns & Scott 1997: 210). In Crane's (1996) review of the empirical studies that have specifically focused on this phenomenon with respect to mathematical learning, various facets of SES, home environment and parental test scores have been identified as all having significant effects on children's mathematical skill levels. According to Crane (1996), most of these studies were non-random, were small samples, and that very little is known about the relationships among all three general determining factors. Crane (1996) was able to access all three variables using the National Longitudinal Study of Youth (NLSY). I discuss these findings in some detail below as it provides a larger population frame in which to consider the experiences of the women and the children in this much smaller study.

### *Effect of Home environment, SES and Maternal test scores on mathematical achievement*

The NLSY is a random sample of people from within the USA who were born between 1957-1964. Apart from including socio-demographic and biographical details, the database includes interviews with family members and the results of a range of psychological and cognitive tests. Using this database Crane (1996) investigated the relationship between SES, home environment and maternal test scores on children's mathematical skill level aged between 5-9 years. Fathers' mathematics test scores were not available in large numbers from this database, but the mother's test score were, which for the purposes of this study makes Crane's findings particularly pertinent. Home environment characteristics included four measures: cognitive stimulation; emotional support; age of weaning and whether parents had read at least once to their child. SES variables included family income, household size and percentage poor at mother's school. Parent

educational levels and occupations were initially included in the first analysis but were dropped due to problems with multicollinearity.

Consistent with previous research, Crane found that all three variables: SES, Home environment and parental test scores significantly effected children's mathematical achievement. The effect of the Home environment was particularly large, even when SES and maternal test scores were controlled. Out of the four home measures, cognitive stimulation and emotional support together had the greatest impact, and each had an impact independent of the other. The effects were large when the children were younger, but were by no means insignificant for older children and this outcome is consistent with the study by Reynolds and Walberg (1992) who found that for grade 8 students; the home environment had the largest indirect effect on their mathematical skill level. In Crane's study, the effects of SES and maternal test scores on children's mathematical achievement were smaller than compared to Home environment, but not trivial. The impact of maternal test scores was also reduced by three-quarters, when home environment and SES were controlled. In other words, being able to achieve well on a mathematics test is not what directly affects how mothers assist their children's mathematical achievement. The results suggest that it opens doors for them career wise, enhancing their SES, which allows them to provide better educational opportunities for their children, and it also impacts through the provision of a more stimulating home environment. Crane summarised his findings as follows:

The results suggest that a standard deviation in all four of the HOME scales ... generate a three-fifths [60%] standard deviation rise in children's mathematical scores. A standard deviation increase in each of the SES measures generated a one-third [33%] standard deviation rise in scores. And a standard deviation increase in maternal test scores generated a one-tenth [10%] standard deviation rise in scores (Crane, 1996: 14).

Crane strongly recommended investing in the research and development of methods to change parent behaviour or improve home environments because the benefits are potentially quite large.

#### *Research on parent-child interactions with respect to the learning of mathematics*

There is a broad acceptance that parent involvement in children's mathematical learning is extremely valuable for their mathematical development, and needs to be encouraged, but there is less agreement over the types of involvement that have the most beneficial outcomes (Baker & Soden 1998). In their review of the literature, particularly in relation to specific parent programs, Baker and Soden suggest that most of the studies are methodologically flawed. Inadequate controls and non-random samples have resulted, they say, in not being able to precisely determine whether reported positive outcomes can actually be associated with parental involvement per se. They suggest we need more rigorous controlled experiments. While such experiments would contribute to our understanding of the issue, rigorous scientifically controlled education experiments are not only near impossible to implement, but they abound with huge ethical issues. Furthermore, quasi-scientific education experiments usually leave us asking for less contrived qualitative data to interpret the findings.

For example, Anderson (1997) conducted an experiment with families of four year old children, sending home a package of mathematical resources that she asked the parents to use as

a way to engage their children in mathematical activities. These sessions were tape-recorded. The parents were not told how to use the resources, and Anderson coded the data to determine the range and types of activities that were conducted. She noted considerable variation in the extent to which mathematical discussions ensued between the parents and the children. She concluded “further research into parent-child interactions during everyday activities is needed to document the characteristics of these supportive environments so that teachers, parents and researchers can put the appropriate value on such activities and gain insights into their contribution to children’s mathematical development” (Anderson 1997: 510).

A recent case study approach by Bottle (1998) assessed parental attitudes towards early mathematics and examined the ways in which six families initiate and support the development of young children’s early mathematical concepts. She found that the longest mathematical activities were those in which the adult and child were actively involved together in their construction. Furthermore, the greater the parent’s awareness of the importance of mathematical development the more time they spent on mathematical activities with their children and the more engaging the activities.

From the child’s perspective on parental involvement, a study by Balli (1997) of middle grade students found a significant number of students believe they do better in school with their parents help with homework. Nevertheless, students reported mixed perceptions and this was based on the extent to which they experienced their parents being facilitative or just telling them the answer and whether they confused them, sometimes with different methods from those used at school.

While the research on parent-child interactions with respect to the learning of mathematics is in its infancy and has focused on early mathematics learning (Anderson 1997) what literature does exist is consistent with the broader reform agenda in mathematical learning. That is, the need to encourage a dialogue of inquiry; to embrace the key role that peers can play in students’ learning through shared meaning making.

Given that parent programs are designed primarily to enhance students’ achievements, there has not been much focus on the impact that parent programs have on parents themselves. Baker (1998) suggests that future research needs to also find ways of measuring the impact of parent programs on parents themselves: their self esteem and feelings about their children. The women returning to study literature, while not a parent program per se, is clearly relevant to this area of the research agenda.

#### *Research on women returning to study and the impact on their children*

The extant literature on women returning to study and the subsequent impact on their children is largely based within the higher education context. Reported in three substantial studies (Burns and Scott 1997, Burns Scott and Cooney 1993, Edwards 1993, Kelly 1987) is that women gain new confidence, wider interests and better conversation skills, and that the women report a beneficial flow-on effect to their children. These authors described this flow-on effect in terms of the women providing specific tutoring support for their children as well as their influence as a role model for learning good study habits, their increased ability to understand their children’s thinking, and the more intellectual climate in the household. “The women spoke of how they felt their children had become better informed because of the discussions, and mentioned that it might also have some effects upon their children’s current and/or future education” (Edwards

1993: 120). Both Kelly (1987) and Burns and Scott (1997) noted that a limitation of their studies was a reliance on the women's impressions concerning the impact of their return to study on their children. An apparent current gap in the literature was the absence of children's voices - their perspectives and experiences - when their mother's return to study.

### *Epistemological Frameworks*

The data reported on in this paper evolved out of a research study that integrated the epistemological frameworks of Belenky, Clinchy, Goldberger and Tarule (1986) and Baxter Magolda (1992) in the context of women returning to study mathematics in the Australian further education sector (Brew 2001a, 2001b). The research focus is consistent with the call for strategies to counter traditional mathematics pedagogy and epistemology which, it is argued, alienates many girls and women by not appreciating or validating their ways of coming to know (Burton 1995, 1996; Becker 1995, 1996). The aim of the study was to assess the extent to which perceived success in mathematical learning was achieved through the changing role of significant others, using an epistemological lens to analyse the data.

Belenky et al. (1986) derived five epistemological perspectives that they related to the metaphorical notion of "voice" in their study of women from diverse backgrounds, who they asked to reflect upon their lives, focusing on catalysts for change and impediments to growth. Mothers were explicitly included in the study as they were "particularly interested in how maternal practice might shape women's thinking about human development and the teaching relationship" (Belenky et al. 1986: 13). The five epistemological perspectives include *silence* (no voice), *received* knowledge (emphasis on listening to the voice of others), *subjective* knowledge (emphasis on listening to the inner voice), *procedural* knowledge (the voices of reason - connected and separate knowing) and *constructed* knowledge (integration of connected and separate ways of coming to know). While Belenky et al. 1986: 24) do not consider their notion of *silence* to be parallel to the other four epistemological perspectives, the authors position it as an important anchoring point in their overall schema. Many of the women in their study often spoke retrospectively about feeling "deaf and dumb". "They felt 'deaf' because they assumed they could not learn from the words of others and 'dumb' because they felt so voiceless".

In her longitudinal study of undergraduates, Baxter Magolda (1992) identified four broad epistemological perspectives: the *absolutist*; the *transitional* knower; the *independent* knower; and the *contextual* knower. The *absolute* knower is very comparable to the *receiver* in Belenky et al.'s framework, and similarly there are elements of the *independent* knower in the *Procedural* perspective. The two models converge in *contextual* and *constructed* knowing as they both represent the development of an authentic voice and a perception that knowledge is socially constructed within given contexts. For further details see Brew (2001b).

Central to Baxter Magolda's framework is that there is a direct relationship between one's epistemological perspective towards knowledge and the role that significant others (identified as teacher and peers) play in learning. For students who view knowledge as absolute, the role of the teacher is limited to imparting the knowledge that is required, and the role of peers is limited to a social one, or at best, to share knowledge gained from the teacher and text. As students gain an appreciation and understanding of how knowledge is constructed, that it is inherently uncertain (*independent* knowing), the views of peers gain greater validity and play an increasingly more significant role in learning. While similar ideas are also evident in Belenky et al., Baxter

Magolda more clearly identifies the changing role of significant others as students' views develop on the nature of knowledge and authority.

## THE SAMPLE

In 1999, 19 women were interviewed who were enrolled at one of the two further education centres included in this study. Of these, 18 were mothers and 10 had school-aged children. This paper draws on data collected on the experiences of seven of the 10 women with school age children, all of whom were early school leavers and ranged in age from 33 to 50 years. Five of these women expressed differing levels of anxiety with mathematics, which, as can be expected, they brought with them into the classroom. The centres where these women were enrolled are located in two of the most economically depressed areas of Melbourne, Australia. One site was a Community Learning Centre, often the first step for women returning to study. The other site was a Technical and Further Education (TAFE) college where courses are better articulated for entry into higher education. In the first year of the study (1999), two classes at the Community Learning Centre participated in the research. One class covered essential numeracy skills as a component of a full time Information Technology course designed to provide the women with computer skills for immediate employment. The other class studied grade 11 mathematics, with the aim of providing them with a mathematics prerequisite to enter the higher education sector. In the year of the study only women were enrolled in these classes though men were not excluded.

The TAFE college course was developed for women who were early school leavers to provide them with a pathway to areas of further study that are non-traditional for women (e.g. engineering, medical technology). This was a full time course with a significant component devoted to mathematics up to year 10 content with a particular focus on algebra. According to the teacher, the women-only class composition was meant to encourage women to take more risks than they might normally have done if men were present. There was also a commitment to group work as it was believed there was immense value for learners to verbalise their own understanding and hear others clarify and justify their mathematical reasoning.

## DATA COLLECTION

Following three weeks of class observations the students were each interviewed over a period of two months. Regular observations of classes continued to the end of the course and the second interview usually occurred by telephone. The interviews were semi-structured covering issues with respect to the five domains of learning of Baxter Magolda (1992) - their perception of mathematics, and the roles of the learner, teacher, peers and assessment. In the first interview students were also asked about their reasons for returning to study, their previous school experiences, particularly in mathematics, and the influence of their parents on their schooling. The follow-up interviews were focused on any apparent shifts in the students' perspectives on the role of the teacher and peers in the mathematics classroom.

During the time that the first interviews were being conducted, I was informed by staff at the Community Centre that one of the reasons that some women gave for returning to study was to provide their children with more homework support. At that time I did not envisage that this issue was related to the central aim of the study and so it was not a focus question in the first interviews. As many of the women spoke in the first interview about the role of their children as

a motivating factor in their return to study and the impact their studies were having on the types of conversations about mathematics they were having with them, this issue became a featured focus in the second interview. During this second interview I also requested the opportunity to interview the women's children. Ten children (four girls and six boys), from four families agreed to be interviewed whose school grades ranged from one to twelve.

## FINDINGS

### *Families of origin*

As noted in the introduction, 'social reproduction' theory is used to explain the lower school achievements of the children of parents from lower socio-economic backgrounds (Burns & Scott 1997). Within this frame of reference there are two deficit models: working-class parents are proposed to value education less highly and to have lower aspirations for their children and/or lack knowledge and confidence to be involved in their children's education due to limited or poor school experiences (Coleman 1988, Hunt 1969, Marjoribanks 1995). Family of origin descriptions that the women provided with respect to the level of support given to their education were consistent with one or both of these two frames of reference. Examples follow to illustrate:

They didn't sort of worry, school was supposed to take care of that. It wasn't to be brought home. Occasionally my homework wasn't done on time and Dad would sit down and try and help. But Mum, well, wouldn't be able to. You were a girl and you were going to finish in fourth form anyway and go on and do office studies. Dad would say, 'you are not doing any good so as soon as fourth form comes up you are out of there.' Not to say sort of, 'why aren't you doing well in maths?' (Linda)<sup>2</sup>

I dropped out at the end of year 10. I was always very good at maths, but in year 10 I had this teacher who you could say was pretty bloody hopeless (laugh) and I found that really frustrating. A lot of the time I was actually showing her how to do some of the work. ... I just went down hill and lost interest then. ... My parents didn't encourage me to stay at school. I just said I am not going back next year and it was all hunky dory, "fine, go and get a job." They were quite happy for me to go out and bring some money in. (Lynette)

Ginsburg (1997: 132) proposes that while these cognitive deficit models assist us in describing aspects of people's situations, they are insufficient in their ability to characterise fully the people who are responding to "the unique demands of their distinctive environments". Withdrawing from the cognitive deficit model requires a persistent focus on understanding learning potential, motivation, cognitive style and the role of socio-political factors through supplementing "our cognitive notions with genuinely psychological and ecological considerations" (Ginsburg 1997: 149). I address these two considerations with respect to the motivation of these women to help their children avoid suffering the learning difficulties that they had endured during their schooling. The epistemological frame helped to reveal the way these mothers and their children made meaning together and drew conclusions about knowledge and authority in the context of learning mathematics.

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<sup>2</sup> All names are pseudonyms.

### *Children as a motivating factor*

Apart from personal development, ambition and financial motivation, all but two of the seven women conveyed that one of their specific reasons for returning to study was to be able to assist their children more academically.<sup>3</sup> These five women implicitly recognised the threat of the transmission factor in 'social reproduction' theory. Support with their mathematical learning specifically featured in their comments. Their experiences resonated with the findings of Burns and Scott (1997), Edwards (1993) and Kelly (1987) with respect to providing not only direct tutoring support but also the wish to be good role models in terms of academic study. For example:

At school I wouldn't even ask questions, ask for help, whereas now I ask, I am there to learn. I don't have the same attitude as I did when I was younger. And I look at my kids and they are probably a bit that way too. They don't necessarily ask when they need help. Leon is a very sensitive kid, and I was too, I never wanted to look as though I was an idiot by asking a question. ... I am actually amazed at what I am doing. I suppose I look at it differently, and I am not going to let it beat me. Like even if I don't sit tests or anything like that, I feel that I can help my kids, and look at things differently too (Clare)

I remember sitting in the year 7 maths room and quaking in fear of all this big maths that we were going to learn. I remember thinking, 'Oh, I don't know if I can do this.' That's funny, because I hear my kids saying it now and I say 'yes you can, yes you can.' ... [later in the interview] They are not requiring their nappy changed, or mashed food on the table, they are requiring a more intelligent person to be around them, and someone who has got the life experience to listen to them. So I decided I had the life experience, probably I needed to brush up on the academic aspect and I think that has probably encouraged me more than anything. To not follow them and not be ahead of them, but to be walking with them. ... And I think maths is definitely an area where I need to be knowing what they are doing. (Samantha)

The kids were coming home and talking and some days I was just switched off. And I thought this is hopeless, ... I am just stagnating. ... With my son he is 14 now and I have noticed his work is becoming a bit daunting, and I felt the need to sort of help him, whereas, my parents didn't do that. (Linda)

To make a particular point at this time I would like to move into the second interview data with Linda where I continued to gauge the role of her children in her decision to study.

*Interviewer: In the first interview you said that 'the kids were coming home some days and talking and you were just switched off and you thought this is hopeless. It sounded like the kids kind of triggered you in some ways?*

Yeah, you do things for your family. I mean, I really, possibly, oh well, I did it for myself I suppose ideally, but in the back of your mind ... like I had this mundane job, ... but I had to get out there and do something and improve myself. FOR the kids.

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<sup>3</sup> All the women with school-aged children in the study, bar one, reported benefits for their children (see Brew 2001c).

What Linda seems convey is that she feels she is breaking a rule when she emphasises that her return to study was very much connected with her family needs. The source of this perceived rule is not clear, though it might be positioned as coming from western feminist discourse that posits the preferability for women to define themselves separately from their role as mothers. The recognition of an 'ideal' that is associated with separateness is resolved by Linda into a connectedness in her self-affirmation that her motivation to improve herself is for her children.

### *Epistemological perspectives on mathematical knowledge and learning*

In the context of women returning to study mathematics in the further education sector, the literature reports that they commonly have a perceived need for procedural over relational understanding (FitzSimons 1996) that is consistent with a belief that mathematics is absolute and infallible (Beesey 1995). At the same time, one of the reasons given for why many women feel alienated by traditional mathematics pedagogy and epistemology is that they perceive no room to give status to their subjective meaning making systems (Jungwirth 1993). The epistemological perspectives conveyed by the women in their first interview towards mathematics and mathematical learning were often consistent with these ideas. For example:

There is one answer with maths, it is either wrong or right. Very clear-cut. That's what I like. It is not so much like that with English, people's personalities come into that. ... In maths there is a right or wrong answer. ... [and with regard to the role of peers] And I am not really looking for the social side of it, that is not really why I am here. I am really here to do the maths (Paula)

I just seemed to have a mental block with maths ... With maths there is a set of rules ... there is a right or wrong answer. You can't sort of manipulate it to suit yourself. (Clare)

While Paula and Clare both held absolutist epistemological perspective towards mathematical knowledge, it is this defining belief that has molded their different attitudes towards the subject: Paula likes the certainty such a perspective brings, Clare on the other hand, seems to be saying she would like to be able to bring her subjective meaning making system to the subject. Paula's view of the role of peers as being mainly social is also consistent with Baxter Magolda's description of the absolutist, who perceives knowledge is certain, that it comes from external authorities and hence peers subjective knowledge does not have a legitimate role in meaning making.

Evidence of the *silent* perspective (Belenky et al. 1986) was also evident in the women's experiences of mathematical learning and the associated belief that one cannot learn from peers, that it is the teacher one needs to defer to for knowledge.

I want a book that gives me all the rules. And say right, this is my rule for doing this exercise, like fractions, or percentages, so I can do them in a block. ... Wanting a rule gives me stability, knowing I can sit there and flick back and find it myself. You don't have to answer, I can't do this, I am silly, I am dumb and stupid. [and with regard to the role of peers] ... Lisa and I struggle with the

same stuff so we can't help each other ... the direction from the teacher is more important, or more precise. (Jane)

### *Shifting epistemological perspectives*

Through these women's experiences of an interactive, and at times, collaborative adult mathematics classroom environment, evidence of an epistemological shift away from an absolutist perspective towards the learning of mathematics emerged.

*Interviewer: In the first interview you said you "viewed maths as a set of rules", that "there is a right or wrong answer. You can't sort of manipulate it to suit yourself."*

Clare: Well I suppose that is the classical, what I enjoy and what I don't. Because with statistics you can, there is no right or wrong answer ... with financial (studies) ... what would some statistics be, you are finding what your median and mean to be. Whereas it is not BLACK and WHITE.

*Interviewer: Why is it not black and white?*

(Pause) Well it depends on the information you are actually using. That's a hard question. ... I found it easier, so, I perceive it as being different. I don't know (laugh).

One interpretation of Clare's reflections is that she has recognised how the different measures of central tendency, in this case the mean and the median, provide the opportunity to interpret data in different ways. It is perhaps intellectually "easier" for her because it suits her way of coming to know. For the first time she perceives there is some flexibility in the interpretation of mathematical knowledge, that there is room for subjective dialogue in making sense of the mathematics. While I do not have direct evidence to link Clare's epistemological shift towards mathematical knowledge with an increasing role of peers in her learning, Clare did allude to the importance of one peer in helping her make the shift away from suffering in silence when struggling to find meaning.

Clare: What I used to find frustrating was that you would get to a point and then I just couldn't go any further, especially with algebra. You would get to a certain point and you would think does this go down there, or what do I do with that? Samantha would say, "well do you remember when we did this?" You know. And I would say "oh yeah".

*Interviewer: She wouldn't necessarily tell you what to do?*

Clare: No. It was good. So I found that great. You couldn't do that in a classroom environment with the teacher up the front. Especially when they have 30 in a classroom.

The shift for Paula was directly linked to the changing role of peers. She began to recognise the value of differentness through learning from the perspectives of others indicating an epistemological shift had occurred.

*Interviewer: In the first interview you said you liked minimal interaction in the classroom. And yet I thought there was more interaction in the classroom later on?*

Paula: Yes there was and I initiated a lot of it too (laugh). ... With Samantha, she had a different perspective on it I think. She saw things very differently to me, and when I got stuck, I could rely on her to, what do you say, look outside the square you live in. ... And I think it would help 100% if the teenagers could do that with each other. I know that would be really hard, because a lot of the kids would carry on and muck around or whatever. But if they were able to feel more comfortable in speaking up then the other kids might be able to think, "oh, is that what it means?" Because you tend to think in your own language don't you?

In the comments of both Clare and Paula is a direct linking of their new experiences with children's schooling, imagining how it might be different, and improved, through encouraging dialogue and shared meaning making in the classroom.

Lynette spoke about the role of the teacher and peers in supporting the shift away from procedural knowing.

The teacher is great because she can explain things in a way you can understand. A lot of hands on, cutting and pasting, you can see the reasoning. Probably better off in a logical sense than learning all the old rules ... that is not study really. (Lynette)

It just broadens your mind, because you do learn from other people, ideas of how they look at things. ... You can look at things from different angles, rather than just the normal way you would look at them, and think, like that's it, that's the way it is, when it doesn't have to be, like that is the way it is, there are different avenues into a problem. (Lynette)

#### *Evidence of increased dialogue about mathematics at home*

The greater confidence that these women gained in the adult classroom literally spilled over into their interactions with their children. They were excited about sharing their new knowledge with their children and described peer-like interactions with their children. For example:

Like I have interesting conversations with my oldest son now. Where I can't understand something he'll say, "have you seen this or have you done that?" or "this changes that." And yet there will be times when I say "can you help me with this?" ... And he will say, "What is that?" And I can teach him where I am up to but I can't go the next step. We've shared. That is important to me. I want the kids to know they are not on their own. (Samantha)

Samantha also described how her daughter who was in year 8 had decided to apply herself to her mathematics subject. She had come home one day to announce she had excelled in an algebra test, and Samantha informed me that normally she would have failed such a test. Her daughter's attitude towards and aptitude for the subject had changed so dramatically that her teacher was discussing the possibility of having her enrol in his advanced mathematics class the following year.

Similar to Samantha's situation with her son, Peta described getting academic support from her daughter in considerable detail. With respect to the impact on her daughter's mathematical learning, initially Peta did not think she had, as her daughter was doing extremely well, and had done so for some time. However, as the interview progressed subtle shifts became apparent.

Peta: My daughter is doing year 9 but she is doing year 10 maths.

*Interviewer: Do you think that she would be in that class if you had not gone back to study maths?*

Peta: I think she would have been there this way or that way. ... She is very bright. She is a straight A student.

*Interviewer: So what impact do you think you have had on her going back to study?*

Peta: Um, with her I don't think I have had much. In fact she has helped me! ... Like she helps me in respect that if I don't understand something, she is more like the way my father used to do it. Sometimes she works from the back forward. She gets the question, she looks at it, if she doesn't understand it she will go and look at the answer. And we think, "Ok, how do we get from that answer from this?" And she will then figure it out.

*Interviewer: So do you think her confidence has grown because she has been able to help you?*

Peta: Yeah, I think it has.

*Interviewer: Are there any conversations that you can remember that would indicate that?*

Peta: Yeah. She is actually gotten a slightly higher mark being so confident.

*Interviewer: Than she normally would have?*

Peta: Yeah. It is not a significant higher mark because she is already getting A's, like 93, or 87. Now she is getting nearer to the 100s. Which really, if you think about it, it might not be significant to everybody else but one or two points might be significant to her.

*Interviewer: So you going back may have kept her interest do you think?*

Peta: I think it has given her that little extra push. The fact that I have started to do further study she has thought, "well if mum can do this, why can't I?"

*Interviewer: Has she actually said that?*

Peta: Sometimes, but in her riddly way (laugh).

*Interviewer: Can you tell me how she talks in riddles?*

Peta: Well the pass mark in a test was 50%, the teacher's competency rate was 80%, and I got 81. Which I was thrilled about, because when I go into a test I normally come out babbling I don't know what I have done. But this time I went in mildly confidently, and thought I don't know what the hell I wrote (laugh).

The next week I have gone "look what I got, 81!" And she goes, "really good mum, but I got a 94 in my maths test!"

While both are having to work with the traditional approach to the learning of mathematics with standard problems and one right answer in the back of the text, Peta's daughter would appear to be teaching Peta how to use all the available information effectively for understanding. Further evidence of this occurring is the shift in pronoun use from "she" to "we" by Peta when she states "she gets the question" and "she looks at it" and "if she doesn't understand it, she will go and look at the answer" to "and we think ok, how do we get from that answer from this". This is suggestive of the emergence of a connecting dialogue about mathematical understanding. The joining in partnership implied by her shift to the pronoun "we" suggests that Peta has located her own emerging mathematical authority within their shared membership in the larger rubric of mathematical knowledge processes. The sense of mother and daughter being learning partners with respect to their academic pursuits is further evident in the playful competition about their respective test scores.

In the second interview with Linda, her comments resonated with Belenky et al.'s notion of the development of one's own voice. There is a sense of her moving away from 'silence' that is epitomised by a sense of feeling dumb and stupid. Linda reveals how her previous feelings, that are likely linked to feelings of shame with being mathematically incompetent, led her to be inauthentic at times in her relationship with her son. Linda said she now invites open dialogue about mathematics with her son.

Linda: I do feel more self-assured. And I do speak out a bit more. Whereas I tended to hang back and think I better not say that because that might be stupid.

*Interviewer: Does that also relate to the kids schooling?*

Linda: Oh yeah. Speaking to my son I speak out more about schooling now than I did before I did the course. In the way that he should think about school.

*Interviewer: In the first interview you said his work was becoming daunting. Are you able to help him now?*

Linda: Yes. I am now because he is doing similar things to what we did last year (laugh). Working out the areas, perimeters. Actually we were only doing that yesterday, and I thought "Wow, I did this! I can do this with you." (Laughing)

*Interviewer: And what does he think about that?*

Linda: He just smiles, he is actually asking ME questions (laughing). Sometimes I have to sit down and think hang on, what did we do here, and then it comes back, and we go ahead with it, so that is good.

*Interviewer: So that wouldn't have happened before?*

Linda: I probably would have looked at it and gone "ask your father". Whereas now, I haven't had to say, "wait till your father comes home" or "don't show me that".

*Interviewer: Did you say that, "don't show me that?"*

Linda: Oh yeah! A couple of times I said, "I haven't got time for that", only because (voice dropped), I didn't know what he was talking about. But now I can read it, say "all right, let's have a look".

Lynette had not been as fervent as the other women about wanting to be able to assist her children more with their academic studies. All the same, a similar story emerged full of the same excitement as portrayed by the other women.

They think it is terrific. It has given them actually a bit of a buzz, because they are more keen now to actually get down and study themselves. ... That has given them a boost. They are really getting stuck into it. And Susie thought it was fantastic because she has been doing decimal work and I would come home with a decimal sheet and we would sit there and do it together. And she is only in grade 5. She thought it was so funny, she says, "I can't believe I am doing the same work as you Mum" (laugh). It was good though. We work on her sheet and then we work on mine. (Lynette)

### *The children's perspectives*

In the context of describing how his mother now helped him with his homework, Clare's son Leon described a near matching style of interchange with his mother that she had experienced with her classroom peer. That is, support was facilitative, inquiry oriented.

Leon: She didn't give us the answers for them, she just helped us.

*Interviewer: Ok. And how did she do that?*

Leon: What do you mean?

*Interviewer: Well you made a distinction between not giving you the answers and something else.*

Leon: She reminded us of things, and if I had forgotten something she might say um, like "do you remember when you did that?"

Leon's comments suggest that the type of peer interaction Clare had come to appreciate in her mathematics classroom, the invitation to dialogue, was now being applied in the home. Leon also conveyed that he felt more able to talk with his mother generally, and she in turn confirmed this perception.

Leon: I don't know if this is with us getting older or something but we have been able to talk with Mum a bit more as in Mum's not really strict, she is still strict, as in we have laughs with her, it has just changed in that way.

Clare: They are probably changing just as much as I am. But I think that my listening skills are better, I am definitely more articulate, and I can express how I feel, and I am more observant of how they feel too. Makes a difference.

These two comments resonate with the findings of Belenky (1996), with respect to an apparent shift away from an authoritarian approach to parenting when the women in her study began to see themselves as thinkers. In turn they became aware of their children's thinking processes. While Belenky (1996) emphasised the "thinking" domain, Clare emphasises the "feeling" domain with respect to her own and her children's learning.

In the interview with Linda's son I followed up her comments about how she now felt able to assist him with his mathematics. This was the only time in the data that any of the children did not corroborate their mother's experience.

Interviewer: Did your mum help you with your maths?

Anton: No, not really (laugh). Sort of had to do that by myself. Maybe small things, but, not that much really, not much I remember.

*Interviewer: Something about measuring areas and perimeters came up with your Mum, she thought she was able to help you with some of that. Can you remember?*

Anton: No, not really, no. ... Most questions, like harder questions, I used to ask Dad to help me with them rather than Mum because Dad knew more about the maths questions than Mum did.

It is difficult to know the extent to which Linda did assist her son with his mathematics, though she clearly recalls trying to do so. In discussing this case with colleagues it was suggested to me that the way his father assists him with mathematics may be quite different from the way his mother does. It was suggested that perhaps his father is more directive, while his mother encourages him to engage in a dialogue about his work. Yet Anton did go on to explain enthusiastically that his mother had been of major support at least in another academic context. "When mum first went to school she didn't know much about computers, then once mum started learning about computers she was really helpful."

Having interviewed Linda and seen the delight on her face in telling me her rendition of the experience, one interpretation is that being able to attempt to assist her son with his mathematics may have been of far greater significance to her than it was for him. Clearly this experience had come to reflect for her a measure of her new mathematical confidence, her ability to now tackle what had once been daunting academic tasks.

The comments from Lynette's daughter confirmed that she was enjoying having her mother share her new learning mathematical with her, and also the opportunity to engage in a dialogue based on meaning making together.

Susie: She helped me with my maths. Because my teacher last year didn't exactly explain everything to me. And that made it a bit harder. So everyday I went back home and asked her to explain it properly to me.

*Interviewer: And did your Mum explain it better than the teacher?*

Susie: Yep.

*Interviewer: Any examples, like one day I had this problem and ...*

Susie: (laugh) Well, one day when we were at school and doing decimal numbers the teacher just, like she likes to talk a lot. And she was just talking about stuff that we don't need to talk about. So, I went back home and my Mum explained everything to me, not like the teacher.

(Later in the interview)

Susie: She would come home when she had learned her maths experiment or something at school and show me it.

*Interviewer: Can you give me an example?*

Susie: Well, (pause) she was doing this thing out of a piece of paper and had to get it like that without cutting it. And so she taught, I tried to do it, and then I finally got it (laugh) ... then ... we got everyone else to do it.

*Interviewer: So do you think your attitude towards maths changed at all because your Mum was doing it at school?*

Susie: Yeah.

*Interviewer: Can you tell me a bit more about that?*

Susie: Well how my teacher never explained anything, I was able to do more of the work than I used to, and it was easier for me.

## DISCUSSION

In this paper I have attempted to portray the impact that returning to study mathematics in the further education sector had for several women both on themselves and their children, a sector known for its transformational potential in adults' lives (Bradshaw 1999). While the number of women in the study was relatively small, there were at least five factors that suggest they represent a relatively homogeneous group. First, their family of origin experiences were similar with respect to being thwarted or unsupported in their educational opportunities. Second, they had spent several years raising their children and had come to a point in their lives where they had recognised a need to make a radical change to enhance both their employment prospects and their sense of personal fulfillment. Third, most of the women were partly motivated to return to study to improve their children's educational opportunities, to break the cycle of learning difficulties that they had experienced in their childhood and to remain relevant in their children's lives as their needs were changing too. Fourth, they had come into their respective courses with a rule based notion of learning mathematics or that in learning mathematics one is only right or wrong, there is no room for interpretation. This notion, in association with their initial perceived role of classroom peers to be mainly social, is consistent with an absolutist perspective on mathematical knowledge and learning (Baxter Magolda 1992).

The ways in which adults made shifts in their epistemological perspectives in the study by Baxter Magolda were also evident in this study. First, there was evidence of an epistemological shift away from an absolutist perspective towards a focus on making meaning through dialogue and interpretation. This was initiated by the formal learning context where peer interaction was encouraged, which then led to the women's deepening appreciation for the value of peers' different perspectives as they assisted in the women's developing understanding. Through the women applying their new knowledge through dialogue in the home with their children they were affirmed and further stimulated in this learning mode.

While previous research of women's experiences on returning to study has documented beneficial flow-on effects to their children generally, what has been largely

ignored is the pivotal role that children can play, in turn, in providing not only a consistent motivating factor but also enhancing their mother's intellectual development. In this study, this occurred through a synergistic effect in their explorations together into new ways of making mathematical meaning. Through the changing dialogue in the home, evidence emerged of a growing sense of mathematical authority, a sense of ownership and perhaps the early signs of authorship (Povey 1995, Povey et al. 1999) of the mathematics. Further evidence suggests that through the greater validity placed on peers' knowledge in the women's learning came a growing awareness of the impoverished pedagogy of the traditional mathematics classroom with its emphasis on individuals working alone.

In Edwards' (1993: 128) typological account of education and family in women's lives she identified an apparent tension between two ideological constructs, "that of separated private and public worlds and a connecting feminine psyche". She identified how some women returning to study strove for "connection and integration" of these two worlds while others strove for "separation". Other women sought "a mix whereby they separated some aspects of education and family, but in other areas they felt and wanted connection." Edwards positioned these ideological constructs as not necessarily existing in reality, nor being static, but rather as positions from which the women begin to move towards or away from over time. Edwards (1993: 138-9) went on to interpret that while retrospectively "one might discern certain particular connecting or separating strategies and their outcomes ... for the women themselves ... they continued to be unintended outcomes rather than goals they worked towards. Their only aim was to move between the two – a process rather than an end." I wish to problematise this interpretation.

At one level the women's experiences in my study resonated more with the women in Edwards study who sought connection between their public and private worlds. Edwards (1993: 129) positioned these "connecting" women as wanting to talk with their families about their academic knowledge, that they felt this, in turn, had affected the way they brought up their children, and, also viewed their family experience and knowledge "feeding into their academic learning". Not discussed by Edwards, however, was the notion that this sense of connection might well be a sustaining motivating factor for their academic studies. This was explicit in the current study. In addition, Edwards did not discuss the issue that the women may have grown intellectually and emotionally from the new dialogue they were stimulating in the home (which is strongly implied in the current study). Upon reviewing some of the participants' accounts in the study by Edwards (1993: 119-120) I find evidence of this phenomenon in her study as well. "[W]e sort of encourage each other" and "We sit around the box ... I use programmes to discuss things" and "doing the degree makes you more aware about how important parent involvement is, ... it makes you more aware".

In the current study, these formerly marginalised women literally constructed the context within which they could reinvent themselves, not in spite of, or to the detriment of, or simply because of or only for their children, but more. By remaining connected to their children and utilising the home environment they were able to discover and experiment with new strengths and exciting dimensions of themselves in an integrated way. By so doing, they had enhanced their emerging authority in connection with

mathematics, increased their confidence in themselves, and developed new partnerships with their children.

Noddings (1984) calls it the joy of the one-caring. What the women seem to have tapped into is a natural synergistic potential between mothers and their children. In contrast to the notion that returning to study ought affirm ideally women's separateness from their children, a perspective that Linda was aware of, for these women the ideal was actually in the connectedness, both from the learning point of view and from their personal commitment to their children. Crucial to this line of argument is that the mother-child relationship, viewed as a teacher-student relationship became more fluid through the children being able to support their mothers with their academic work. Through their support of their mother, the children enter into the transformational process of moving from being exclusively the one 'cared-for' to participating as the 'one-caring' (Noddings, 1984). This is why it is synergistic, not just in terms of intellectual exchange. It is further synergistic within the rubric of care (Noddings 1984).

The implications for practice is that rather than just the public world (the formal learning setting), being the source of new knowledge and ways of how to engage effectively with students about mathematical meaning, the private world of the parent-child relationship deserves greater attention for its potential contribution to constructing new mathematical knowledge. It is through this connectedness that I believe the potential for challenging the hitherto non-negotiable mathematics curriculum and addressing the nature of knowing mathematics may grow.

The reason this synergistic potential has been largely overlooked in the literature is, I suggest, because we have been focused elsewhere. In the early stages of this research project, before I had developed some of the ideas presented in this paper, I would have conversations with my academic colleagues about the role of children in the women's motivation to return to study and that through working with their children it seemed to be assisting the women's intellectual development. Quite often, the non-verbal response would be to roll their eyes. The verbal response was to suggest that the women were merely rationalising their self interest by hiding behind their dedication to their children. One adult educator said she would like to see the proof of how it helps women as when adult students finally make the shift to focusing on their own learning and away from their children's, that is when the adult practitioner often quietly celebrates a sense of personal achievement. Perhaps there is some truth in this interpretation, but I see clearly now that it comes from a deficit model. It is based on women being deficit for not feeling fully entitled to pursue further education for themselves, and that children are deficit in terms of only being able to deplete their mother, that they are incapable of giving something back. The other truth I believe is more inclusive and celebratory. We have accepted the normative ideology that the private world of mothering is less valuable academically than the teaching that occurs in the public domain and that learning at school is other to mothering. Apparently this is simply not so. The women's stories discussed here are of transformation, of growing mathematical confidence and shifting epistemological perspectives, with both their classroom peers and their children playing a central role in this process. It is my hope that these ideas will resonate with and encourage others to look at this under-explored dynamic - mothers and children as peers in shared mathematical meaning making.

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