DOCUMENT RESUME

ED 455 094 SE 064 752

AUTHOR	Brew, Christine R.
TITLE	Women Returning To Study Mathematics: An Epistemological Journey?
PUB DATE	1999-00-00
NOTE	21p.; Paper presented at the Combined Meeting of the Australian Association for Research in Education and the New Zealand Association for Research in Education (Melbourne, Australia, November 29-December 2, 1999). Contains small print. "This research is supported by a La Trobe University postdoctoral fellowship research grant."
AVAILABLE FROM	For full text: http://www.aare.edu.au/99pap/bre99404.htm.
PUB TYPE	Reports - Research (143) -- Speeches/Meeting Papers (150)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	Adult Education; *Epistemology; *Females; Feminism; Foreign Countries; Mathematicians; *Mathematics Education; Postsecondary Education

ABSTRACT

The societal perception that mathematics is absolute and infallible reinforces a transmission pedagogy and is considered to be a major stumbling block for women returning to study mathematics. Children at risk in mathematics are found to rely on rules and procedures and similar findings are evident with adults. A reliance on rules is consistent with an epistemological perspective that knowledge is absolute and external to the self. This paper is work in progress on the usefulness of two feminist epistemological frameworks to understand the experiences of women returning to study mathematics. Two contexts in the further education sector are included in the study, a Community House and a TAFE college. (Contains 47 references and 8 tables.) (Author)

Women Returning to Study Mathematics: An Epistemological Journey?

by
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BRE99404

Paper presented at the combined annual AARE & NZARE Conference, Victoria, Australia, 1999

Women returning to study mathematics: An epistemological journey?

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Abstract

The societal perception that mathematics is absolute and infallible reinforces a transmission pedagogy and is considered to be a major stumbling block for women returning to study mathematics. Children at risk in mathematics are found to rely on rules and procedures and similar findings are evident with adults. A reliance on rules is consistent with an epistemological perspective that knowledge is absolute and external to the self. This paper is work in progress on the usefulness of two feminist epistemological frameworks to understand the experiences of women returning to study mathematics. Two contexts in the further education sector are included in the study, a Community House and a TAFE college.

Introduction

This paper is work in progress from a study that seeks to link three research areas: ways of knowing; women returning to study mathematics; and the transformational process of further education. Two feminist epistemological frameworks, Belenky, Clinchy, Goldberger and Tarule (1997), first published in 1986, and Baxter Magolda (1992), are integrated and positioned alongside interview data to illustrate the epistemological perspectives of women towards mathematics. Such perspectives are the ways students interpret or make meaning of their educational experience as a result of their assumptions about the nature, limits and certainty of knowledge (Perry, 1970). Collectively these perspectives form *ways of knowing* (Kitchener, 1983).

Background

Previous research on gender and mathematics has largely focussed on school children (see Leder, 1992) as has research on mathematics education more broadly ; . With respect to girls and mathematics, lower participation is the major focus of concern because of the reduced occupational pathways this ultimately confers (see Rogers & Kaiser, 1995). For Australian girls from lower socio-economic backgrounds, gender exerts a major influence on mathematics participation rates (Lamb, 1997).

The outcomes of gender-based studies have frequently resulted in the implementation of strategies focused on encouraging girls to adopt male norms with respect to mathematics, with varying success (Kenway & Willis, 1986; Willis, 1990). That women's and not men's relation to mathematics is considered problematic is informative (Jungwirth, 1993). Lamb (1997) proposed that one explanation for girls to not pursue mathematics, particularly those from lower socio economic backgrounds, is how they "come to *view"* the subject (p.110). This notion echoes the broader call for strategies for countering traditional mathematics pedagogy and epistemology which has alienated many girls and women by not appreciating or validating their ways of *knowing* (Burton, 1994; 1995, 1996; Becker, 1995, 1996; Jungwirth, 1993). If there are gender-related approaches to mathematics, that is, different ways to experience mathematics as meaningful and different ways of mathematical teaching that make or do not make sense, then the tendency for more females than males to turn away from mathematics may well be that "rather than being victims of gender-role expectations they would rather like to live in worlds that make sense" (Jungwirth, 1993, p.142).

Giving status to "subjective meaning" in the analysis of females' relation to mathematics (Jungwirth, 1993) is to challenge the widely held belief that mathematics is objective and represents an absolute body of knowledge. Despite this core assumption having been convincingly challenged (see Ernest, 1991, Lakatos, 1976; 1983), to include both pedagogy and epistemology in the discussion of gender and mathematics is difficult because disentangling the inter-relationships between them is complex (Burton, 1995).

> It is exceedingly difficult to dismantle the beliefs which have been integral to our learning experiences of mathematics, and almost impossible to construct in our imaginations alternatives to the processes which we have been taught and with which we have gained 'success'. Hence scratch a pedagogical or philosophical constructivist and underneath you are likely to expose an absolutist. ... it might be acceptable to negotiate a curriculum or introduce a collaborative, language-rich environment with which to make the learning of mathematics more accessible, but the mathematics itself is considered non-negotiable. ... to be consistent in our critiques we cannot avoid addressing the nature of knowing mathematics along with the philosophy and pedagogy of the discipline (p.281).

The adult and further education sector

The community education sector plays a vital role in the ongoing learning of adults, particularly for women. For those people for whom the schooling system has failed, it is a truly community-oriented sector that provides a safe, friendly, and non-coercive learning environment (Teese, Davies, Polesel and O'Brien, 1999). Prior to the 1990s, adult and community education providers had greater freedom over the design of their courses to meet the needs of their individual students (Teese et al., 1999). With the introduction of outcome-based education (OBE) in 1992 (Collins, 1993) funding for further education providers is now closely linked to the provision of certified courses where the nature of teaching, learning and assessment have become interwoven components (Spady, 1993). The curriculum framework is the Certificates in General Education for Adults (CGEA) which provides for four levels (Marr et al., 1998).

The introduction of a competency based learning model signalled a clear shift of emphasis from input to outcomes (Beevers, 1993) and as Kinsman (1992) noted, the "competency based training system of learning is quite deliberately silent on the preferred process of learning ... (as) it is stated that competencies can be acquired in a wide variety of ways" (p.57). More recently, the strengths of the Adult and Community Education sector in terms of providing a more holistic approach to learning are being put back on the formal agenda. The Adult Community and Further Education (ACFE) Board, working within OBE requirements, has produced a conceptual framework document titled *Transforming Lives, Transforming Communities* (Bradshaw, 1999). This document has formalised into policy four key principles to enable the naming and evaluating of further education curriculum: multiplicity, connectedness, critical intelligence and transformation. These principles strongly resonate with the epistemological schemas proposed by Belenky et al., (1997) and Baxter Magolda (1992).

In 1997 around 100,000 Victorian adults were enrolled in the further education sector . About 10% of these people enrol in certified courses, and of these, less than a third (29%) go on to tertiary study (Teese et al. 1999). This is predicted to increase and current policy directives have been aimed at creating greater articulation between certified courses to provide a "seamless" pathway to higher education (Teese, et al., 1999). For these students, mathematics remains a critical filter for them into future qualifications (Burton, 1994) and is evident from recent Australian data on enrolment patterns in non-traditional areas. For example, in 1996, 18% of female school leavers versus 23% of their male counterparts enrolled in science, compared to just 9% of female mature age students and 17% of their male counterparts (DETYA, 1996).

Women returning to study mathematics in the further education sector

Over the past decade the standard of numeracy among adult Australians has been highlighted as an area for improvement (Wickert, 1989, Dawkins, 1991, Cummings, 1997). Yet for many adults returning to study, enrolling in a mathematics class is usually not on their agenda. Lack of success at school often coupled with a fear of mathematics leads adult students to avoid the subject. Only through a high level of commitment and encouragement on the part of providers are adult mathematics classes provided at current levels in the further education sector (Marr et al., 1998). Burton (1994) describes mathematics in further education as an "exceedingly difficult area" because "absolutism is "apparently unquestioned and the worksheet is ubiquitous" (p.216). As the market is small, there are few published resources for adult learners and teachers.

Women returning to study mathematics invariably hold the view that mathematics is absolute and infallible (Beesey, 1995), and they have a perceived need for procedural over relational understanding (FitzSimons, 1996). This orientation towards the learning of mathematics is often coupled with a high level of anxiety (Carroll, 1994) and together are perceived to be the major stumbling blocks in defining mathematics for these women. Research studies concerning women returning to study mathematics do report considerable success (eg. Beesey, 1995; Feil, 1995; Helme, 1995; Isaacson, 1990; Burton, 1987). Success for women in these courses was attributed to over-coming a fear of the subject through a teaching philosophy that incorporated the common-sense knowledge of the women, that drew upon and valued their own experiences, that focused on practical applicability, and promoted a collaborative classroom environment. Broadly speaking, these success stories did not address the nature of the women's epistemological assumptions about mathematical knowledge and whether these changed over the duration of the courses to promote more complex ways of mathematical knowing. Marr et al. (1998) have expressed some concern that despite efforts to present relevant and interesting mathematics tasks to adult students, they do continue to keep mathematics in a compartment separate from everyday life.

Table 1: The epistemological models of Perry (1970), Belenky et al. (1997) and Baxter Magolda (1992) and a sketch of their proposed overlap

Theorists		
Perry (1970)	Belenky, Clinchy, Goldberger & Tarule (1997)	Baxter Magolda, (1992)
• Men • 124 initial interviews 98 final interviews. Harvard University students • 3-5 interviews over undergraduates years.	• Women • 135 women 90 academic institutions# 45 family agencies • Intensive 2-5 hour interview(s) #	• Women and men • 101 initial interviews 70 final interviews. Miami University students • 3-5 interviews over undergraduate years
Epistemological perspectives and proposed overlap with Perry according to Belenky et al and Baxter Magolda		
(not evident)	**Silence**	(not evident)
Dualism	**Receive**	**Absolute** • *Receiver (emphasised more by women)* • *Mastery (emphasised more by men)*
Multiplicity	**Subjectivity**	**Transitional** • *Interpersonal* • *(emphasised more by women)* • *Impersonal* • *(emphasised more by men)*
		Independent • *Inter-individual (emphasised more by women)* • *Individual (emphasised more by men)*
Relativism	**Procedural** • *Connected knowing* • *Separate knowing*	**Contextual** *Different reasoning patterns proposed to be integrated*
Commitment	**Constructed**	

The academic institutions: prestigious women's college; rural progressive coeducational college; inner-city college serving mixed ethnic and less advantaged student body; innovative college taking younger students; alternative public high school serving students of college age but at risk of dropping out of school. Of the 90 women interviewed at these colleges, 25 had been previously interviewed in a related project.

Ways of knowing

Becker (1996) suggested two feminist epistemological theories that might be valuable guiding frameworks in future research on gender and mathematics: *Women's Ways of Knowing (* Belenky et al, 1997) and Baxter Magolda (1992), *Knowing and reasoning in college: Gender-related patterns in students intellectual development* . Belenky et al.1997 has previously been incorporated in this area (see Becker, 1995, 1996; Erchick, 1996; Koch, 1996; Morrow, 1996).

Belenky et al. (1997) re-examined the major work of Perry (1970) who articulated privileged white-male intellectual development through Harvard university undergraduate years, extrapolating his findings more broadly. Perry (1970) proposed a hierarchical intellectual epistemological scheme with nine positions which are frequently collapsed into four categories: *Dualism; Multiplicity; Relativism; and Commitment* (Table 1). *Dualism,* is an absolute orientation towards knowledge and truth, epitomised by polarities (right/wrong; good/evil; success/failure). For a pure dualist faced with two different perspectives, one must be wrong. Through a strong association with Authority as the holders of knowledge, learning is oriented towards reproducing and memorising. *Multiplicity* is an emerging acceptance of multiple perspectives in areas where knowledge is considered uncertain. In this situation anyone has a right to his or her opinion including the self. Hence there is an emerging confidence in holding personal authority. *Relativism* in its later stages is the rejection of absolute truth entirely where context plays an important part in assessing knowledge. This is associated with the affirmation of personal authority and can lead to *Commitment* . This position is characterised by a perception that meaning making, once expected to come from outside themselves through Authority, emanates from within. A commitment is made to an uncertain future.

Apart from being all women, the sample studied by Belenky et al. (1997) varied from Perry in that the participants were drawn from diverse socio-cultural and educational backgrounds. The methodology also varied as the women were usually interviewed only once (though some women had been interviewed in a previous related study). The women were asked to reflect upon their lives focusing on perceived catalysts for change and impediments to growth. Significant divergence from Perry (1970) was noted, particularly the impact of the greater obstacles many women experienced in their intellectual development and their more distant relationship to authority.

Using a grounded theory approach Belenky et al. (1997) proposed five perspectives from which women view reality and draw conclusions about truth, knowledge, and authority: *Silence (no voice); Received knowledge (listening to the voice of others); Subjective knowledge (listening to the inner voice); Procedural knowledge (the voices of reason - connected and separate knowing)* ; and *Constructed knowledge (integration of the two Procedural voices)* (Table 1).

Belenky et al. (1997) were far more reticent than Perry (1970) about proposing the model as developmental across stages.

> In Perry's scheme, there is a clear sequential ordering of positions and, although ... individuals can retreat or temporise, he does believe that each position is an advance over the last. ... Harvard is clearly a pluralistic institution that promotes development of relativist thought. ... The linear sequence in developmental stands out clearly when the context ... is held constant. When the context is allowed to vary, as it did in out study, because we included women of widely different ages, life circumstances, and backgrounds, universal developmental pathways are less obvious. We leave it to the future to determine whether these perspectives have any stagelike qualities." (p.15).

More recently in response to the debate over whether the notion of "development" is a viable construct anyway, Goldberger (1996) states that for those who choose to use the scheme have to consider what determines a person's shift in epistemological perspective over time. While the determinants may be developmental they could also be contextual, strategic, political or cultural factors. Goldberger (1996) also addressed the issue of appearing to mislead readers into believing they were promoting an essentialist position because of the title of the book. The theory is to be understood as a generalisation about most women and this model may also best describe the intellectual development of many men.

Baxter Magolda (1992) replicated Perry's (1970) study but included near equal numbers of males and females. She obtained broad overlap with Perry's schema describing four broad hierarchical stages of intellectual development: *Absolute Knowing, Transitional knowing, Independent knowing* , and *Contextual knowing* (Table 1). Each position is considered a developmental advance of the other that is broadly associated with the rejection of absolute thinking towards decision making in context. Within the first three positions, she identified gender-related reasoning patterns which she hypothesised to converge in *Contextual knowing.* Her model also describes five domains within the stages: the perception of knowledge, the role of the learner; peers; the teacher; and evaluation. As students moved through the various stages, their perceptions in relation to these domains shifted. For example the role of peers increased, the teacher's role became more of a facilitator, and they expected greater input into their own evaluation. The models of both Belenky et al and Baxter Magolda are discussed further throughout the paper in relation to the context of this study.

Methodology

Integration of the two frameworks

I chose to use Baxter Magolda's model as an overall starting framework in this study and have then attempted to integrate the five perspectives proposed in *Women's ways of knowing* . There are three main reasons for this strategy. First, Baxter Magolda appears to have identified aspects of both Perry and Belenky et al.'s models through the identification of gender-related (not gender-dictated) reasoning patterns. When listening to the women in the study it was important to be open to hearing different voices that may present within each perspective. Second, the five specific domains she identified provide a very useful structure for a formal learning setting to allow for the interrogation of complex text into somewhat discrete areas and hence a way of teasing out what has been called, 'the prevailing winds of change' . Third, Baxter Magolda provides a finer scale schema for the shift towards holding multiple perspectives through two positions, Transitional and Independent knowing. This contrasts with the single perspective of *Subjectivity* (Table 1).

The strengths of the model proposed by Belenky et al. for this study are three fold: 1) Unlike Baxter Magolda, women from lower socio-economic backgrounds were included; 2) The *Silence* perspective can be clearly identified with mathematics anxiety that women commonly experience when they return to study. 3). While both Belenky et al. and Baxter Magolda describe two related processes: the development of a genuine "voice"; and a shift towards viewing knowledge as inherently uncertain, Belenky et al. emphasise the former, Baxter Magolda the latter. The notion of "voice" is particularly pertinent to the discussion in terms of the need to encourage students (particularly girls and women) to construct and contribute their mathematical ideas (Morrow, 1996) when mathematics is still widely perceived and taught as an autonomous activity (Koch, 1996).

The apparent overlap of Belenky et al. and Baxter Magolda evident in Table 1 occurs by default because of the broad overlap these authors identified with Perry. A more deliberate integration of the two models is set out in the paper.

Research Sites

Two contexts are included, a Community House and a TAFE college, both set in two of the most economically depressed regions of Melbourne. At both sites courses run during the day and on-site child-care is provided. With respect to mathematics in particular, teachers are sensitive to catering for students who have experienced previous alienation with the subject.

The Community Centre had three mathematics courses in 1999 and two of these classes participated in the study. One class was CGEA level II numeracy (2.5 contact hours per week over two terms). This class was a component of a full time Information Technology (IT) course. The women enrolled in this course were seeking to improve their computer skills to obtain employment and nearly all were anxious to learn that there was a compulsory numeracy component to the course. The second class was level III&IV CGEA mathematics/Year 11 VCE) (2.5 hours per week), planned to run over two years. Some of these women were keen to enter higher education. The commitment of this community house to provide a range of levels of mathematics is conveyed in the following comments of the mathematics teacher. What is also evident is how fluid the levels are within individual classes due to tight budgetary constraints.

> Most community houses don't teach maths. This house is only little, but we have several maths classes, which is extremely unusual. ... One thing that is obvious with teaching adults is that they come to the class with a complete range of abilities and expectations and skills. And it can be extremely wide from can't remember how to add up or take away, to wanting to do VCE. By default they are in the same room at the same time. There must be a negotiated curriculum for each student or else they will not cope, and vote with their feet and not come. Because of the way the house is structured, students' language skills dictate which level class they are in. ... I have to have the lower level students in the same room because there is not enough money to teach them separately. So we have got two levels in the VCE class anyway.

The TAFE class is level II CGEA mathematics (7.5 hours per week over one year) and is a component of a full time course leading to two certificates within the CGEA. The ability to provide three times the contact hours compared to the community house was due to greater flexibility in funding arrangements through the combining of two certificates. The course was designed to provide a pathway for women wishing to enter areas of further study in which they are traditionally under-represented as is evident from the teacher's comments below.

> There was a need to provide a course to help women have science and maths as an option, and it was very much denied them if they had left school early. They were coming in saying, "gee I really wished I had done this, I really would like to go on to Engineering areas, it has always fascinated me, or lab tech." So it was in response to a perceived need, it matched a time when it was starting to be well documented that girls in school were not choosing maths sciences but were going for the humanities.

The participants

The women at the community centre were mostly in their mid to late thirties (age range 30-50). At the TAFE college, the women were on average slightly younger, (age range 22-50). Nearly all participants had children at home. Of the 18 women interviewed, thirteen had not completed Year 12, with 4 only going as far as Year 9. Regional factors played a role as two women had attended country schools where there was no Year 12. Other reasons given for leaving school early included: long bouts of illness; request by private school principal as the student was believed to be unable to pass the HSC; money; to care for siblings; peer pressure; parents encouraged them into low paid stereotyped employment; abandoned by parents; and incest. There were two women whom I was surprised to see in a mathematics further education class. One of these women had a BA (psychology) and had therefore completed several years of tertiary statistics, and the other had been a supervisor for a large corporation and was partly responsible for a 200 million-dollar budget.

Data Collection

Four types of data have been collected; 1) interviews, 2) observation of 15 lessons, 3) video taping of classes midway and towards the end of the course, and 4) a short answer questionnaire developed by Baxter Magolda called the *Measurement of Epistemological Reflection* (MER), modified, with permission, to suit the context.

The two mathematics classes at the Community Centre, by default, were women only, and were taught by the same teacher. Initial observation of the classes began close to the start of the courses, and after two weeks of rapport building, participants were invited to participate in an initial interview. The TAFE class was women only by design and observations did not begin until close to half way through the course. The reasons for the high attrition across classes were varied (Table 2): illness; unable to cope with the demands of full time study with children; and enrolling in other courses that were more likely to provide immediate employment opportunities. The reasons given by women for not participating in interviews included lack of time and current difficulties in their private lives.

The interviews were semi-structured. The broad questions were concerned with: reasons for returning to study and the associated catalyst(s); school experiences, particularly in mathematics; previous adult studies; current family situation; their experience of the teaching in the course; their perceptions of mathematics; and the role of the teacher, peers and assessment.

Table 2: Classes included in the study

	Community House setting		TAFE
	IT numeracy	VCE year 11 mathematics	Mathematics class
Initial class size	12	12	15
Final class size	10	6	6
Women interviewed	5	6	7

Teaching methods

The teaching methods adopted at the two sites varied and across classes. In the IT class identical work was provided to all participants. Usually each lesson began with a new topic drawing on students' previous knowledge and skills. Illustrations of different ways to solve basic numerical problems relating to everyday experiences were commonly introduced. Worksheets with supplied answers (aimed at providing students with control over their own learning) were provided and these formed a large component of the class activities. Whole class tasks were initiated each lesson that often involving estimation problems. These activities generated a sense of fun and cohesion of the group.

In the VCE class there was enormous variation in the mathematical background of the students and this led very quickly to two distinct groups. The four VCE level students worked from both worksheets and a textbook. Project work, as part of the work requirements was also set that required peer collaboration. The two other students voiced an inability to cope with VCE level and were provided with individually designed worksheets. Most teaching was one-to-one. The VCE students did begin to initiate discussions with each other on the mathematics and met outside normal class time as a study group. Over time the differences within the group grew and all students were studying at different levels after third term. Peer interaction subsequently declined in the classroom.

At the TAFE college there was a commitment to group work, the use of concrete resources, encouragement of the women to voice their thinking, and a focus on conceptual understanding. Strategies were introduced to demonstrate how mathematical rules were developed. Answers to problems were not generally provided (initially), as this was believed to encourage a focus on obtaining a right answer at the expense of having the confidence to know one has understood the problem. Over time with attrition and frequent absenteeism, maintaining group work did become a challenge for the teacher. No textbook was used in this class, and work sheets were provided to provide the avenue for skill development. Frequent one-to-one attention also occurred during each class.

Integration of the frameworks

Four of the five domains described by Baxter Magolda are included in the integration of the two frameworks. The changing role of evaluation has been dropped temporarily to help simplify the process. Indicators for the existence of epistemological perspectives with respect to the learning of mathematics are proposed in table form from the descriptions these authors provide (not from the data itself). Extracts from the interviews follow, all from different persons, which appear to resonate with these proposed indicators. When discussing individuals, elements of more than one epistemological perspective are expected to emerge, particularly if shifts in perspective are occurring. It is important to emphasise that this paper is work in progress and that the proposals put forward are tentative.

Table 3: Silence (page numbers refer to Belenky et al. (1997)

Silence	Proposed indicators for epistemological perspective in mathematical learning
Perception of knowledge	
• Understanding knowledge is not possible nor important(p.28) • Undeveloped capacity for representational thought (p.25).	• Dependence on "blind" rule following, or rote learning. Understanding mathematical concepts is not important
Role of learner	
• Feel deaf and dumb, have trouble talking due to fear of being punished or ridiculed (p.23,24) • Harsh school experiences (p.23) • Lack of dialogue with the self (p.24,31)	• Maths anxiety invoked readily, fear of being wrong. Associated with an internal deprecating voice that is related to prior school experiences. • Unable to explain how they have solved a mathematical problem. Refer to the rule as an explanation of their actions
Role of teacher	
• Passive, reactive & dependent on external authority for direction and truth (p.27, 28). • Blind obedience to authority as of utmost importance to ensure survival (p.28) • Authorities tell you what is right and never tell you why it is right (p.28)	• Dependence on one-to-one attention from teacher to be shown exactly what to do. • Hard worker but tendency to be "Deaf" to teacher explanations • Unable to say "I do not understand"
Role of Peers	
• An inability to find meaning in the words of others or learn from others' experience (p.26)	• Peers play no role in mathematical learning

Silence

The designation of silence is not parallel to the other terms chosen to describe the epistemological positions proposed by Belenky et al. (1997). While rare in their sample (women usually spoke about it in retrospect), it was viewed as an important anchoring point for the epistemological scheme for it represents "an extreme in denial of self and dependence on external authority for direction" (p.24). Not unexpectantly, "silence" did not emerge as a theme in Baxter Magolda's study of undergraduate students though reference is made to the notion of a silent voice (p.91). In Table 3 the characteristics of *Silence* as described by Belenky et al. are provided with the proposed indicators in a mathematical learning context. Students who suffer from a high level of mathematical anxiety and who therefore struggle to reason mathematically would appear to most closely fit within this perspective.

In this study, 10 of the 18 women indicated they struggled, to varying degrees, with mathematics anxiety or an internal self-deprecating voice. The example provided comes from a student who from interview illustrated many of the proposed indicators of the "Silent" mathematics student. There is evidence, however, that the participant is shifting from "silence" to a *Receiver* perspective, discussed in the next section. Ironically, this student described herself in the classroom as "Jolly, vocal. Too loud, too noisy."

Example of the "Silent" learner in mathematics (Jane - VCE)

I would like a book that gives me all the rules, alphabetically . [Dependence on external authority through rule following] ... *I would like to sit down and have a book in front of me and say "right, this is my rule for doing this exercise", like fractions, or percentages, so I can do them in a block.* [Blind and repetitive rule following but a hard worker. Peers have no role in learning implied]. *But if they change the concept around and I have to do another fraction, it is different rules to that, that is where I don't think quickly enough to get it.* [Struggling to reason mathematically and hence some evidence of the Receiver emerging]. ... *I have had one to one basis where a teacher explained for two or three or four weeks, a bar graph, which is the simplest thing* [Dependence on one on one attention and "deaf" to teacher explanations]. ... *It is funny what mistakes you make, but if a teacher has that funny little laugh, ... it is really hard to sit there, ... they are not laughing at what you have done wrong, they can actually see the mistake and want to help you. ... but that laugh can penetrate and wound you so hard* . [Mathematics anxiety invoked readily, as are prior negative school memories and a fear of being ridiculed]. *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. You see?"* [Uncommunicative with peers implied through wanting to work alone. Not wanting to be dependent on the teacher emergent but is related to an inability to say that she does not understand. Maths anxiety invoked readily and associated with self deprecating internal voice]

Absolute Knowing

Belenky et al. and Baxter Magolda both describe a way of knowing characterised by absolute thinking. For the comparable perspective in Perry (dualism), the self is defined primarily through a strong identification with and trust of Authority, who have all the answers. This perspective is summarised as "authority-right-we" (p.257). In Belenky et al. the absolute perspective was better described as "authority-right-they" (p.44). That is, while the women in their sample "were as awed" they "identified less with authorities" (p.44). Baxter Magolda appears to have captured these two forms of absolute knowing though the identification of the two reasoning patterns, R*eceiver* and M*aster* (Table 1&4). Both Baxter Magolda and Belenky et al. use the term *Receiver to* describe a way of knowing that is epitomised by a reliance on listening, and a dependence on external authority for gaining knowledge (Table 4).

Table 4: The Absolute knower ('B': Belenky et al. (1997) and 'BM': Baxter Magolda (1992).

Absolute Knowing	**Proposed indicators for epistemological perspective in mathematical learning**
Domain: Perception of knowledge	
• Absolute. One is either right or wrong, good or bad (B p.37, p.41, BM p.74) • Confused by ambiguity (B p.42;BM p.74,88)	• Believe one can only be right or wrong in mathematics • Confused by more than one way to solve a problem. Ambiguity must be resolved to either right or wrong
Domain: Role of learner	
• Reproduce knowledge of authority. Unable to evaluate or perceive a process in learning (B p.39,42, BM p.73) • Incapable of original work (B p.40)	• Mathematics consists of learning rules. Have difficulty evaluating different approaches to solving problems or discussing concepts • Unable to apply the mathematics outside given contexts
Receiver • Learn by listening (B p.37, BM p.81) • Little confidence to speak, still their voices to hear others (B p.37; BM p.91) **Master** • Prefer a verbal approach to learning, asking questions, volunteering to do problems, which raise the teacher's awareness of them (BM p.92, 93)	**Receiver** • Quiet listeners and recorders of information • Reluctant to discuss their mathematical reasoning publicly **Master** • Ask questions to get attention from the teacher. More likely to volunteer to do a problem on the board
Domain: Role of teacher	
• Capable of learning but truth is derived from external authorities (B p.37). Teacher's role is to provide knowledge and students to accept it (BM p.76)	• Reliance on the teacher to communicate mathematical knowledge appropriately and to make sure they understand it.
Receiver • Teachers role is to provide a relaxed environment to enable them to enable	**Receiver** • Seek a relaxed atmosphere in the mathematics classroom.

them to make clear what they know (BM p.82,85) • Minimal interaction with the teacher unless for clarification (BM p.101) lack of questioning of teacher's style (BM p.85) **Master** • Stronger identification with authority and expect quizzing from the teacher to aid their mastery (BM p.101) • Expect to be entertained and pushed by the teacher and can be critical of the teaching (BM p.92, 93,94)	• Questions are infrequently asked of the mathematics teacher • Acceptance of the types of mathematical tasks set by the teacher **Master** • More likely to engage, challenge, and ask questions of the teacher. • Expect tasks set to be interesting

Table 4 continued: The Absolute knower

Absolute Knowing	**Proposed indicators for epistemological perspective in mathematical learning**
Domain: Role of Peers	
• Peers do not have legitimate knowledge, but can share knowledge obtained from authority (B p.39; BM p.78,79) **Receiver** • Peers' role is to create relaxed atmosphere and to ask questions to relieve pressure (BM p.84) • Tendency to shape their thoughts to match those of others (B p.38) **Master** • Quiz peers to aid each others' mastery of knowledge (BM p.92,99,102)	• To share notes, and explain what they have learnt from the teacher. Defer to the teacher for "proper" explanations. **Receiver** • Predominantly social. Peers encouraged to ask questions • Quiet checking of peers' answers for validation. **Master** • More public checking of peers' answers and explanations. Competitive, testing each other. Engage publicly with peers who have a different answer from theirs.

The mastering reasoning pattern, more evident among males, were students who described being more verbal in class and who identified strongly with the teacher. Baxter Magolda describes the *Receiver* as not having any real voice and having a more detached attitude towards authority while *Mastery* students seem to "imitate the voice of authority" in an effort to "to join them as knowers" (p.101).

Elements of the absolute orientation were evident among all but one of the 18 interviews and the views expressed resonated far more with the receiver-pattern though elements of mastery emerged. In the first interview extract, the student conveys that a shift is occurring from silence to a receiver-pattern. The notion of her epistemological perspective for mathematics being contextual is conveyed in her comparison with her English studies.

Example 1: Absolute knower and receiver in mathematics (Clare- VCE)

[At school] maths and reading were always a chore for me. I don't know why. Maybe because I was so quiet and I never asked for help. I wish I was like I am now! (laughter) ... I am trying to look at it in a totally new light compared to when I was younger. [Silent at school but a shift implied]. *I am trying to tackle one stage at a time, like I am plodding, and I am not thinking yet.*[An emerging belief that she is capable of learning but wanting to go slowly, elements of the silent learner still evident in terms of not thinking yet]. *As to rules, I suppose there is really rules. Isn't there? And as (the teacher) said, it is a matter of practising where you sit down and look at something, and you think "oh how do you do that again?" So I have to drag around, get all my examples, and then go "oh yes!" (laugh).* [Defer to the teachers' voice to provide self direction. Learning by following rules]

Interviewer: Would you see maths as just a set of rules?

Probably. Yeah. It is not so much like that with English. People's personalities come into that.

Interviewer: And they don't in maths?

No, because there is a right and wrong answer. You can't manipulate it to suit yourself

Interviewer: There is no interpretation?

Yeah. [but] I am enjoying it, more so than I thought (laugh). [A belief you are only right or wrong in mathematics and opinions of peers have no role]. *Because Samantha is doing it as well it makes it easier (laugh). And then Pauline decided to do it so that was good. But they are all characters. ... like we had 6 ounces of something, like ratios, and they all went "Ooh!", because normally I am usually six steps behind (laugh). But that particular one I was all right. Relate it back to cooking. Everything else is a challenge.* [The role of peers is predominantly social, validating and sharing answers. Her confidence in mathematics emerged from being able to apply the mathematics to her everyday life, a sense of ownership of the mathematics. That everything else is a "challenge" implies the rest of mathematics exists external to the self].

The second example is a more confident mathematics learner but who also portrays a similar absolute orientation towards mathematical knowledge. On the role of the teacher, Danielle articulates the importance of being valued as a learner which has encouraged her to shift from being a silent learner.

Example 2: Absolute knower and receiver in mathematics (Danielle - VCE)

To me there is one answer with maths, it is either right or wrong. And if you get it wrong then you can work out the right answer. Very clear-cut. That's what I like. ... If you get it wrong you can find the answer... [Mathematics is absolute and a belief in being able to learn it]. *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* . [The role of peers is predominantly social]. *I don't think they (teachers) are just there to teach the subject, I think they are there, and they are doing it, reinforcing your confidence with it. So many people, and I did two years ago, you start with no confidence, you think you are a dummy, you think you are just good at changing nappies. And I think the role of the teacher is to reinforce that you are valuable, that you have a place in society, that you are important. Not just to teach you.* [Evidence of the struggle with the internal self-deprecating voice of the silent learner and a shift due to being validated by the teacher]

Transitional, Independent and Subjective knowers

At the position of emerging acceptance of legitimate multiple perspectives the integration of the two models becomes clouded. Using the Transitional and Independent knowing positions as the starting point, the notion of *Subjectivity* by Belenky et al. is included where it provides greater depth and understanding of the process of the development of a genuine voice. Subjective knowers still hold a conviction that there is truth, but truth is derived from personal experience and hence contradictory knowledge of external authority can be rejected. Legitimate multiple perspectives exist because everyone has different personal experiences and so everyone's opinions are valid. Further elements of subjective knowing that contribute to the integrated model are a reliance on intuition, and a distrust of abstract and logic.

Transitional Knowing is characterised by a greater focus on understanding over replicating information. There is an emerging belief that not all knowledge is certain and that authorities are not all knowing. Receiving and mastery students encounter this experience differently. "Mastery-pattern students' identification with authority prompts them to persist in using certainty and logic as much as possible to confront uncertainty. Receiving pattern students detachment from authority makes it easier for them to relinquish the idea of certainty and accept uncertainty." While peers take on a greater role in learning for both patterns, "those embracing uncertainty more readily assign legitimacy to classmate's ideas." (Baxter Magolda, 1992, p.102) (See Table 5).

Receiving pattern students are described as adopting an interpersonal-pattern, focusing on uncertainty and become more attuned to listening to their peers' views. According to Baxter Magolda, the role of teachers is difficult to assess. While still perceived as the holders of truth, their role has shifted to facilitating the sharing of students' experiences. Through their detachment from teachers they "seem readier to adopt their own voice" (p.134). Baxter Magolda (1992) drew a parallel with subjective knowers. Belenky et al. "speculated that women's freedom to explore their own voice and release from authority's monopoly on knowledge accounted for their enthusiastic embrace of uncertainty. This idea could hold true for interpersonal-pattern students as well" (p.116).

Table 5: The Transitional knower ('B': Belenky et al (1997) and 'BM' :Baxter Magolda (1992).

Transitional Knowing	Proposed indicators for epistemological perspective in mathematical learning
Domain: Perception of knowledge	
• An acceptance that some knowledge is uncertain but still believe absolute knowledge exists (BM p. 107) • Recognition that things are not always one way (BM p. 105)	• An emergent belief that in some areas of mathematics there is uncertainty. • An acceptance of there being more than one way to solve mathematical problems
Domain: Role of learner	
• A shift in focus from acquiring information to understanding (BM p.105) • Emphasis on applying rules over memorisation (BM p. 111)	• The need to understand gains precedence over following a rule • Focus on the application of rules in maths
Domain: Role of teacher	
• Role of the teacher is to use methods aimed at understanding (BM p. 105) **Interpersonal Pattern** • Teachers role is to create rapport between students and self-expression (BM p. 114)	• A focus on conceptual understanding over rule following appreciated **Interpersonal Pattern** • Appreciate teacher who encourages peer interaction and the verbalising of the mathematical language.
Impersonal pattern • Teacher's role is to challenge students to think and to focus on understanding (BM p. 114	**Impersonal pattern** • Appreciate teacher who challenges them to explain their reasoning
Domain: Role of peers	
• Peers take on a more active role (BM p. 105) **Interpersonal Pattern** • Greater interest in the views of peers as they provide exposure to new ideas (BM p. 134, 114) • (Subjectivity) A shift to viewing truth as personal, private, intuited (B p.54, 56). • (Subjectivity) Answers from outside world can be discarded (B p.54)	• .Open to hearing peers' explanations of how they have solved a problem **Interpersonal Pattern** • A greater valuing of one's own and peers' knowledge as this provides different ways of understanding the mathematics. • Personalise mathematical knowledge to their private lives. • Mathematical knowledge has to be personally owned or will be rejected.
Impersonal Pattern • Peers support the development of mastering the learning process but their views not valued as such (BM p. 123)	**Impersonal Pattern** • Interaction with peers is primarily to support the development of their own mathematical voice and understanding

Mastery-pattern students are described as adopting an impersonal-pattern where there is a shift from mastering the material to mastering the process of learning. Peers' knowledge is not valued as much as it is within the interpersonal-pattern, "only their contribution to an environment where debate could be used as a personal learning technique" (p.133). Baxter Magolda's description of the role of teachers for impersonal-pattern students is to promote understanding and to challenge students through debate.

All but one of the 18 interviewees expressed elements of Transitional knowing in their current experience of mathematics, though some did much more than others. With regard to the impersonal and interpersonal reasoning pattern, such a distinction was not particularly apparent nor was a sense of an emerging belief that some areas of mathematical knowledge may be uncertain. Instead, elements that seemed to resonate with this position were in relation to a greater focus on understanding and the increasing legitimacy of peers' knowledge.

Example 1: The Transitional knower in mathematics (Colleen - TAFE)

Well in maths (the teacher) is great because she can explain things in a way that you can understand it (laugh). A lot of hands on, cutting and pasting, you can see the reasoning behind a certain problem. That's good because that sticks in your mind. Probably better off in a logical sense than learning all the old rules and stuff, because that is not study really. A couple might, but if you don't know the reasoning behind why you have got this rule you are buggered, you are not going to remember it. [The need to understand gains precedence over rule following. Appreciate efforts of teacher to encourage conceptual understanding].

In the second example, there is an apparent shift occurring from the receiver position. The student clearly identifies one of the barriers for collaboration in mathematics that reinforces a belief that mathematics is something to be done alone. Yet there is the belief too that peers can support mathematical understanding.

Example 2: Transitional knowing in mathematics (Danielle - VCE)

Interviewer: So you are saying that you tend to work alone?

I do. I find that while we all connect well, we help each other out, ... our brain goes in different directions or something. If we are working through something, Samantha can completely loose me, I can have no idea of what she is doing and I do the same to her. She says "I don't know what you are doing!" But we usually end up with the same result. But we go different ways there. ... Which is why people need to work for themselves, like sometimes we can help each other just in the theory behind it, the reasoning behind it. [Acceptance of different ways to solve mathematical problems as valid].

In the next example, the student conveys strong elements of a Transitional-Subjective knower in mathematics. The additional extract that follows comes from the same student where they conveys elements of the mastery and impersonal reasoning pattern in terms of being more verbal, competitive, focused on the process of learning and associating strongly with the teacher. Interestingly, this student was the only person to state that she wished there were some males in the class to provide some balance.

Example 3:The Transitional (Subjective) knower in mathematics (Amy -TAFE)

Unless something makes complete total sense to me I refuse to acknowledge it. My brain just discards it. And I think (the teacher) knows that, because unless I own it completely, it took me a long time with my fractions, but before it was almost as if people were magically pulling numbers out, and because I think it is a magic trick my brain goes no, it's not real, and wipes it. [The need to understand gains precedence over following a rule. Mathematics has to make sense now otherwise refuses to accept it as truth - answers from outside world can be discarded. Knowledge has to be owned.] *Her teaching method suits me, and I have never ever been taught the way that she teaches me. And I have been to three different high schools, and a private primary school where the money was there. ... Fractions, that was my biggest block. Every year I would cringe building up to these frigging fractions, and then, it is such a simple thing, yet no teacher ever did it. She gave us a full circle, she gave us another circle with a half, half each, all together, put that on top, thirds, quarters, up to 16ths, and we sat for about a week with these things and we did fraction additions, and subtractions, using these, fraction circles you call them, and at the end of the week I am the best in the class at fractions, I topped the test. And it was like the penny dropped, and I was just going, Oh!, I get it! That's what they were talking about, they weren't pulling numbers out of their bum and putting them on the board! (laugh). I struggled with it for so long that it will always be my high point.* [Appreciate and value highly teacher's methods that are aimed at understanding and helping to apply knowledge.] *And I realise I have been using [maths] everyday, and not acknowledging it. Like I am a waitress now, I have to work out my own change from the till, never had to do that before, and I have learnt how to count back the money. I use it for cooking, with my daughter, medicines when she is sick. I am a lot more confident. Taking temperature, all the little things which I knew I could do, but I would be really unsure and I would get someone else to check it.* [Personalising the mathematics].

I am very loud, very outspoken, and I know I have pissed people off. ... I like to talk, everyone knows I like to talk. But I don't think I am loud to a point where I don't let no one else in the room talk. ... and once I understand I let go and let someone else talk. [A focus on her own understanding]. *But usually Jess and Colleen, they get it, and they leave, and I end up sitting there, and it makes me feel awful thinking I am trailing behind them, when I am not really! ... But (the teacher) said "Jess and Colleen, natural ability 100% brilliant ... they take it, race ahead and then leave, and they don't absorb it." She says "that's why you beat them in the test, because you take it, absorb it, and practice it, and know it, and own it, and then you beat them in a test." And this keeps me going sometimes when I see them walk out, and I am still sitting there grinding my teeth. And that is the only reason I beat her.*

[Verbally oriented in class, competitive, striving for mastery over the process. Strong association with the teacher].

Independent Knowing

The Independent knower of Baxter Magolda also has parallels with the subjective knower proposed by Belenky et al. in terms of being associated with the gaining of a stronger personal voice, the internal validation of one's own opinion and others, and that the knowledge of authorities is no longer viewed as the only source of knowledge. This shift towards relativism, where all knowledge is inherently uncertain, and opinions are equally valid, is the central perspective of the Independent knower (Table 6). According to Baxter Magolda Independent knowers "rarely provide criteria upon which judgments are based" (p.146).

There was only one example to draw upon from the interview data that seemed to resonate with elements of the Independent knower. In the example below, the student describes an interaction with a peer where there appears to be elements of the inter-individual pattern in terms of an appreciation of listening to another person's viewpoint to support her own learning process.

Example 1: Transitional - Independent knower in mathematics (Pat -TAFE)

Like with Fran, I was showing her the way I was doing it, and she was sort of not really understanding it. But then she did it another way and said "well is this way wrong?" And I said "no, it is just different." But because of how I explained the way I was doing it, she was able to better understand it, but still do it her way. And her first reaction was the way she was doing it was wrong. And I said no, it is not wrong, it is just different. You were taught that way, I was taught this way. But if I have been able to help you understand it better, that's good. But do it your way. She did it her way and still got the same answer, and I was able to let her know, no, it is not always just one way to do something, there is more than one way, as long as you get the right result. [Acceptance of a peer's different way of solving a problem. A move away from a focus on right and wrong answers and different methods accepted as equally valid. No judgment offered as to whether her own strategy or her peer's was more valid than another in the given context]

Table 6: The Independent knower (page numbers refer to Baxter Magolda, 1992)

Independent Knowing	**Proposed indicators for epistemological perspective in mathematical learning**
Domain: Perception of knowledge	
• Knowledge is inherently uncertain and open to many interpretations though judgement of perspectives is rare (p.137, 146)	• Emphasis on being right or wrong in mathematics is replaced by the greater valuing of diverse methods and explanations. Judgement as to which methods are more valid is rare.
Domain: Role of learner	
• The development of individually created perspectives is enhanced because the risk of being wrong is eliminated (p.146) • Feel free to express their point of view and invest time in thinking for themselves (p.140, 142)	• Greater risk taking as less concern with getting a wrong answer. • Gain a stronger and confident voice to use mathematical language. Allow themselves time to understand the mathematics.
Domain: Role of teacher	
• Authorities are no longer seen as the only source of knowledge (p.137) • Prefer teachers who promote independent thinking and exchange of opinions (p.139)	• Teacher's role is to provide an environment in which different approaches to solving mathematical problems are valued.
Domain: Role of peers	
Inter-individual pattern • All opinions accepted. Advocate listening to others' interpretations and espousing their own (p.147)	**Inter-individual pattern** • Greater openness to peers' reasoning and their own to share understanding. Value peers' different ways of solving

	problems as it assists them in understanding their own reasoning.
Individual pattern • All opinions accepted. Appreciate exchange, and debating with others but secondary to thinking for themselves. Struggle to listen carefully to others' voices (p.156, 162)	**Individual pattern** • Seek to explain and debate their own mathematical reasoning with peers to support themselves in their own mathematical understanding.

Procedural knower

The further integration of the two epistemological frameworks is complicated. The Procedural knower, t*he voice of reason,* as described by Belenky et al. resonates with aspects of both the Independent and contextual knower as described by Baxter Magolda. For example, the two voices described within Procedural knowing, connected and separate knowing, parallel, to some extent, with the interindividual and individual reasoning patterns of the Independent knower respectively.

Connected knowing builds upon the subjective position, valuing the different insights of people which in turn supported the challenging of one's own perspectives. Connected knowing is a listening, empathetic orientation and therefore parallels to some extent with the interpersonal pattern of Independent knowing. Separate knowing is described by Belenky et al. (1997) as the "opposite to subjectivism" (p.104) as it is an epistemological orientation that is objective. The knower emphasises distance from the ideas of others, preferring to challenge them, doubt and think critically. They are described as dispassionate adversarial. The individual-pattern resonates with separate knowing, for while exchange with others is important through debate and defending a position, this is secondary to thinking for themselves. In the study by Belenky et al. (1997), most of the Procedural knowers emphasised one of the voices over the other.

According to Clinchy (1996) connected and separate knowing have been commonly misread from their original description. In an attempt to clarify the concepts Clinchy (1996) describes connected knowing as an empathetic approach where the listener on hearing an argument that contradicts their own thinking, seeks to place themselves in the shoes of the speaker in an effort to understand why they think the way that they do. Connected knowers "are not concerned with the soundness of the position but with its meaning to the knower" (p206-207). It is the "believing game" rather than a demand for "logical or empirical justification" (p.206). Separate Knowing is a reasoning pattern that seeks to find flaws in arguments, searching for possible omissions of alternative viewpoints that would contradict a position. Separate knowing is described as the "doubting game" (p.206) or playing the devils advocate.

The main reason as to why there is not a complete overlap of connected and separate knowing with the two reasoning patterns of Independent knowing is that Baxter Magolda states Independent knowers rarely provide criteria on which judgements are made. That is, there is an emphasis on the acceptance of multiple perspectives as being equally valid. As Procedural knowers "are interested not just in *what* people think but in *how* people go about forming their opinions, feelings and ideas (Belenky et al., 1997, p.97) this way of knowing could be viewed as an epistemological perspective that extends the Independent knowing orientation.

Baxter Magolda drew parallels between her model and that of Belenky et al. proposing that connected and separate knowing were extended through links to all three gender-related reasoning patterns. What I interpret from this is that connected knowing evolves through the proposed shifts from the *receiver* to *interpersonal* and then to the *interindividual* pattern perspective. Similarly for Separate knowing in relation to mastery, impersonal and the individual-pattern perspective. This does make sense for it does seem strange that suddenly two distinct voices emerge.

In Table 7 I have chosen to provide a general description of the Procedural knower. The domains of learning identified by Baxter Magolda for Independent knowing (Table 6) can be usefully applied in this case in relation to the role of the learner, the teacher and peers. In the interviews there was no evidence of Procedural knowing in relation to mathematics.

Table 7: The Procedural knower (page numbers refer to Belenky et al. (1997)

The voice of reason	Proposed indicators for epistemological perspective in mathematical learning
• Some truths are truer than others (p.93) • Intuitions may deceive, truth is not immediately accessible. Speaking often requires conscious, deliberate, systematic analysis (p.93, 94)	• Along with acceptance of different ways of solving mathematical problems some methods can be better than others and to decide between them needs careful consideration
Connected knowing • Personal reason. Seek to understand how others develop different perspectives from their own (p.113).	Connected knowing • When a problem is solved in a different way, or an answer is different from one's own, seek to understand the reasoning that has led to this outcome.
Separate knowing • Impersonal reason. Play devil's advocate, seek logical contradictions in arguments (p.93)	Separate knowing • When a problem is solved in a different way, or an answer is different from one's own, a focus on finding contradictions in the logic of other's thinking.

Contextual and Constructed Knowing

The two models seem to converge again in contextual and constructed knowing. These two epistemological perspectives represent the development of an authentic voice along with a perception that all knowledge is socially constructed within given contexts (Table 8). According to Baxter Magolda, while thinking for oneself is the core element of the Independent knower, Contextual knowers extend this position "to thinking for oneself within the context of knowledge generated by others' (p.168). The nature of knowledge is contextual, socially constructed, and is judged on the "basis of evidence in context" (p.170). While definite opinions can be held, Baxter Magolda's contextual knowers described being flexible in terms of being "amenable to new knowledge" (p.177). There is also a focus on integration and the application of knowledge in context. This perspective was rare in Baxter Magolda's sample and she did not identify gender-related reasoning patterns.

Constructed knowing was also rare in the sample of Belenky et al. It is epitomised by being articulate, reflective, and integrating both aspects of separate and connected knowing. There is the development of an authentic voice through a recognition that all ordinary human beings are engaged in the construction of knowledge. There is an acceptance of a "responsibility for evaluating and continually re-evaluating assumptions about knowledge" (p.139). So called authorities are appreciated for their expertise but their knowledge also needs to be evaluated within context. All knowledge is a construction and truth is a matter of context. Ambiguity is also welcomed as it reveals complexity and the need for careful thought. Hence considerable overlap exists with Contextual knowing as described by Baxter Magolda. In Table 8 the two models are tentatively integrated. In terms of mathematics, another aspect of this orientation might be a greater awareness of the limitations of mathematics. FitzSimons et al. (1996), propose the importance of neither an implicit faith nor condemnation of the subject but the usefulness of mathematics as being sensible is considered case by case.

Only one student expressed a view of mathematics that is consistent with elements of the contextual/constructed way of knowing. She was the only student to challenge outright the notion of mathematics being a set of rules and to have thought about how mathematics is used, or misused, within the broader social and political context.

Table 8:Contextual/Constructive knower ('B':Belenky et al (1997) and 'BM':Baxter Magolda (1992).

Contextual/Constructive Knowing	**Proposed evidence for perspective in mathematical learning**
Domain: Perception of knowledge	
• Not troubled by ambiguity, and are enticed by complexity (B p.137, 139,140). • Knowledge is contextual, to be judged on the basis of evidence (BM p.171, B p.138) • Some ideas are more valid than others (BM p.170)	• Accept ambiguities and complexities in mathematical knowledge as authentic and being indicative of the use of mathematics in social contexts. • The usefulness of mathematics being sensible needs to be considered case-by-case (related idea from FitzSimons et al. (1996) • Mathematics is fallible, and social context assumes importance - related to an awareness that political and social policy can be critiqued as it is based on mathematical modelling
Domain: Role of learner	
• Exchange and compare perspectives (BM p. 171) • Integrate and apply knowledge (BM p. 171, B. p.134)	• A perception that mathematics is not something done alone • Mathematical knowledge does not consist of discrete topic areas but rather can be integrated and usefully applied outside given contexts.
Domain: Role of teacher	
• Promotes application of knowledge in context (BM p.171) • Promotes evaluative discussion of perspectives (BM p.171) • Experts need to convey humility about their knowledge area (B p. 139)	• The teachers role is to facilitate integration and application of mathematics through discussion. • Teachers should not present themselves as the ultimate authority of mathematical knowledge
Domain: Role of peers	
• Peers' knowledge is valued when it is justified (BM p.175) • Listening to others no longer diminishes capacity to hear their own voice. A capacity for speaking with and listening to others while simultaneously speaking and listening to the self (B p.145)	• Justification of alternative methods by peers are sort and valued • Evidence of integrating their own thinking with others' experiences in the classroom

Example: Contextual/Constructed knowing (Ingrid - TAFE)

Interviewer: Is maths like a series of rules?

See I don't think higher maths is, I mean there probably are rules but higher maths is not a physical thing is it?

Interviewer: The rules are tools but that is not the maths?

Yes.

(Later)

I find accountants very boring people, they have no imagination. (laugh)

Interviewer: What makes you say that?

They are very dull, very unimaginative people. Maths in the wrong way.

Interviewer: So what would be the right way?

Oh, being creative.

Interviewer: Can you give me an example?

Well, look at Stephen Hawkins, although I can't bear listening to him. But yes, that's maths in the right way. Communicating with people.

Interviewer: So there is a right and a wrong way with maths?

No there is a right way for some people, and accountants aren't the right way with me! I just have a complete blank with accountants. They make decisions based on a financial basis, and there is no humanity or creativity. Don't get sick! Not in the Victorian Health system (laugh).

Discussion

The two epistemological models of Baxter Magolda and Belenky et al. have been tentatively integrated in this paper for the purpose of analysing the experiences of women returning to study mathematics in the further education sector. The integrated model could be applied in other learning contexts.

In courses aimed at catering for the needs of women returning to study, particularly in mathematics, it seemed reasonable to propose that "success", in part, may be due to providing a learning environment that provides for a pathway of intellectual development that women generally relate to more easily. Further analysis of other data sources and follow-up interviews will provide more in depth material as to whether this type of judgement might be made.

The interview data did provide extracts that resonated strongly with three of the epistemological perspectives from the integrated models: *silent* , *absolute, and transitional knowing.* Elements of the more complex ways of knowing, *Independent, procedural and constructed/contextual knowing* were rare in relation to mathematical learning. The notion of *Silence* is particularly pertinent for many women returning to study mathematics and it was a strong theme in the interviews in relation to mathematics anxiety and more generally in relation to a self-deprecating voice. If the integrated model is developmental, this raises the question as to whether silent learners need to move through a stage of being *receivers* before they can become *transitional and independent knowers* in mathematics. FitzSimons (1996) highlighted that the immediate need of women returning to numeracy classes is often procedural understanding that is in conflict with the teacher's intention for longer-term relational understanding. *Receivers* have a tendency to shape their own thoughts to match those of others, magnifying the experiences of similarities with others. Belenky et al (1997) argue that it is this kind of relationship that is most helpful in eventually enabling them to disentangle their own voice from the voices of others and to allow them to move on into more complex ways of knowing. Baxter Magolda argues that students need to be validated "during absolute knowing rather than waiting for their voice to emerge" (p.345) and evidence that this was occurring in the classrooms in this study did emerge.

In the studies by Belenky et al. and Baxter Magolda changes in the participants epistemological perspectives occurred over several years. In this study, over the duration of one academic year, it is unlikely that huge shifts will be noted, although Perry (1970) did indicate that the shifts, when they did occur, occurred rapidly. This could be likened to the notion of some critical mass being reached in conflicting perspectives. The value of Baxter Magolda's model is the ability to notice subtle shifts particularly in relation to ways of learning with peers. What did emerge from the interviews with the students is one of the barriers they experience in terms of collaborative learning, namely not being able to really understand their peers' explanations of their mathematical thinking. Whether this is to do with an epistemological belief that peer's views are not legitimate or more to do with lack of opportunity to develop their mathematical voice is not clear from the data. Follow up interviews will seek to clarify this issue.

One of the issues I will address in this study is the notion of contextual epistemologies. That is, the women's general life epistemologies: eg, how they view knowledge; how they make decisions; how they view the role of peers generally in their life; may well be quite different from their epistemology of mathematics. If so, do the women integrate these two epistemologies over time or do they remain contextualised? An epistemological clash between English and mathematics (see Burton, 1994) was made evident by some students suggesting that their mathematical epistemological perspectives were more contextual than developmental.

In this paper attention has been paid to only four of the five domains outlined in Baxter Magolda (1992). Future papers will be aimed at giving greater space to each of these domains along with decision making for further study. Already the role of children is emerging as an additional epistemological domain (see extract below), which may be a way forward to expand upon Baxter Magolda's model for women returning to study.

> I realised that they (my children) are requiring different things of me. They are not requiring to have 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 realising that whatever I do now will be applicable later. And I think maths is definitely an area where I need to be knowing what they are doing. I just have interesting

conversations with my oldest son now and you know, where I thought 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, I don't understand what I am doing" 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. (But) we've shared. And that is important to me. I want the kids to know they are not there on their own.

To inquire into the experience of learners in any setting also requires an exploration of the institutional factors that are operating. As McIntyre (1995) states in the context of research on adult learning, "it is too limiting for research to take either an institutional perspective or a learner perspective as an exclusive frame of reference" (p.126). Too few funded hours were a major factor for the VCE class at the community house because the funding was strictly linked to competency based outcomes. Yet to not provide such a course would essentially eliminate the lack of access for the women in the district to a safe, friendly, and non-coercive mathematical learning environment. The need to also adopt creative funding arrangements at the TAFE to provide adequate teaching hours is a testament to the commitment of teachers and coordinators to provide adequate space for women to learn mathematics. As FitzSimons (1998) said, some teachers are managing to "operate in the interstices" (p.195).

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Acknowledgments

This research is supported by a La Trobe University postdoctoral fellowship research grant. To the students and teachers who allowed me to come into their classrooms and to talk with me about their experiences, thank you for your generosity. I would also like to thank the following people for providing critical feedback on earlier drafts of this paper, Gilah Leder, Mary Barnes, Beth Marr, Hazel Hughes, Jude Ocean, Helen Forgasz, Julie Lynch, Colleen Vale and Jan Thomas.

SE064752

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