Research into Teacher Beliefs: Can the Past Stop Endless Repetition?

Allan Leslie White
The University of Western Sydney
<al.white@uws.edu.au>

Research into teacher beliefs has a long and troubled history and there is evidence that it is ignoring the lessons of the past. Why do researchers need to continually report the mismatch between espoused beliefs and enacted beliefs? Behaviour is driven by action theories that are different from espoused theories and both are difficult to unravel, but attempts have been made with varying degrees of success. What can history tell us about the definition of belief that focuses upon a global statement or upon a specific behavioural belief statement? Is it still useful to attempt to place teachers upon a continuum based upon their espoused beliefs? Research into the planning, thinking and decision making of teachers should provide insight into classroom events and be worth understanding because of the connection with student learning and performance. This paper discusses these issues and their implications for teacher education.

Research into teacher beliefs has a long and troubled history and there is evidence that it is ignoring the lessons of the past. There is a growing body of literature that claims mathematics teacher beliefs affect teacher classroom practice although the nature of the relationship is highly complex and dialectical (Pajares, 1992; Thompson, 1992). Mathematics teacher beliefs can usually be thought of as individual perspectives of engagement with mathematical tasks and pedagogical practices (Schoenfeld, 1985). Studies of teacher beliefs suggest that there is a causal relationship with action although it is difficult to uncover and explain. So while some studies strongly suggest that teacher beliefs influence instructional behaviour, other cases suggest that instructional practice influences teacher beliefs (Buzeika, 1996; McGalliard, 1983). There is a long tradition of research that has reported mismatches between teachers' theories and behaviour (Thompson, 1992; Cooney, 1985, Shield, 1999), where there are obvious inconsistencies between teachers' espoused beliefs and the resulting classroom practice. Other studies of teacher beliefs collect a pool of teacher beliefs while making little or no effort to uncover a link with classroom behaviour. There are some studies that do not investigate the relationship at all while leaving the reader to infer that the particular pool of teacher beliefs just collected has something to do with action. How then are teachers and researchers meant to navigate this maze of conflicting and confusing material? This paper will attempt to provide some guidelines that have their basis in past research.

Sadly the past is often ignored when it comes to the study of beliefs and to the problems afflicting this area of research. For example, why do researchers need to continually report the mismatch (Thompson, 1992) between espoused beliefs and enacted beliefs? Early researchers such as Argyris and Schon (1974) reported that behaviour was influenced by individual action theories and they identified and described espoused theories and theories-in-use (action). They expected that individuals would use an action theory that was in harmony with their espoused theory, yet what they discovered was quite

B. Barton, K. C. Irwin, M. Pfannkuch, & M. O. J. Thomas (Eds.) *Mathematics Education in the South Pacific* (Proceedings of the 25th annual conference of the Mathematics Education Research Group of Australasia, Auckland, pp. 690-697). Sydney: MERGA.

the opposite. Not only were there significant differences between the two types of theories but often the individuals themselves were unaware of the mismatch (Argyris, 1993). They also reported that individuals developed a number of strategies that contributed to this lack of awareness. This was true for both individuals and groups, thus:

> whenever undiscussibles exist, their existence is also undiscussible... These cover-ups, and their cover-up, are indications of organisational *defensive routines*, which may be defined as any policy or practice that prevents organizations (and their agents) from experiencing embarrassment or threat *and* at the same time prevents them from identifying and reducing the causes of embarrassment or threat (Argyris, 1993, p.621).

This helps to explain how professionals avoid learning and perhaps why researchers continue to repeat belief studies reporting inconsistencies between espoused and enacted beliefs, for it shows how defensive reasoning blocks learning in spite of a high individual commitment to learn. Argyris and Schon presented alternatives for effective change that presented a theory of action to enhance human activity, responsibility, learning, effectiveness and self-actualization. People are taught to recognise the reasoning they use in designing and implementing certain behaviour and they are helped to identify the inconsistencies between their espoused and actual theories of action. This method has been successfully adapted to helping successful people learn more effectively (Argyris, 1991), and promoting effective organisational change (Argyris, 1993). The key to the process lies in the discovery, examination and discussion of a range of teacher action theories.

There has been considerable work done to uncover both types of theories (Argyris & Schon, 1974; Ajzen & Fishbein, 1980; O'Hare, 1987, Ajzen, 1988; Argyris 1993). White (1999; 2000 a, b) conducted a series of investigations into the action theories of teachers. These studies uncovered and reported theories associated with specific teacher classroom behaviours by collecting sets of behavioural beliefs through the use of phenomenography (Marton, 1986) and then applying a modification to the model titled the Theory of Planned Behaviour (TPB; Ajzen, 1985). The results were called teacher action theories to distinguish them from Argyris and Schon's earlier work. Using a different methodology, Keast (2001) conducted a study of three secondary teachers. His study was able to identify what were called the 'testable beliefs' of the teachers, in order to enable the teachers to reflect upon and ultimately alter their practice.

What becomes clear is that espoused beliefs or theories should be also regarded as being linked to the behaviour of the teacher, but not the classroom behaviour. Rather espoused theories are the beliefs teachers are comfortable exposing to public scrutiny. Thus espoused and theories-in-use, are really different types of action theories. They differ because their contexts differ. The specific situations, the teacher's behaviour and the intended consequences are not the same. Espoused theories contain an individual's beliefs, attitudes, and values that are used to describe and justify behaviour. Whereas theories-in-use or action theories are based upon actual human behaviour. Barkatsas (2001) examined the espoused beliefs of 345 Greek secondary mathematics teachers regarding assessment. While the cross-cultural comparisons were interesting, is it necessary to do a follow-up qualitative study "in an attempt to identify inconsistencies between teachers espoused beliefs and beliefs in practice" (p.369)? Research into the planning, thinking and decision making of teachers should provide insight into classroom events and be worth understanding because of the connection with student learning and performance. History has repeatedly demonstrated the folly of concentrating upon only one member of this pair of beliefs and action. For example, a concentration upon action:

> It has now been well documented in several studies that teachers asked to change features of their teaching often modify the features to fit within their pre-existing systems instead of changing the system itself. The system assimilates individual changes and swallows them up. Thus. although surface features appear to change, the fundamental nature of the instruction does not. When this happens, anticipated improvements in student learning fail to materialize and everyone wonders why (Stigler & Hiebert, 1999, p. 98).

Cobb, Yackel and Wood (1988) argue that neither beliefs nor practice have primacy, but that "beliefs and practices are dialectically related" (p.24). This suggests that teacher professional development is likely to be a long-term process where the teacher may need to examine and develop their long-term belief systems as well as work at changing practices. Stigler and Hiebert (1999) regard teaching as a cultural activity where teachers share a mental picture of what teaching is like. They call this mental picture a script. They assert that these cultural scripts are learned implicitly, through observation and participation, and not by deliberate study.

> The scripts for teaching in each country appear to rest on a relatively small and tacit set of core beliefs about the nature of the subject, about how students learn, and about the role that a teacher should play in the classroom. These beliefs, often implicit, serve to maintain the stability of cultural systems over time (Stigler & Hiebert, 1999, pp. 87-8).

The implicit nature of these theories has other implications Berliner (1994) who reported that:

> Experts have an intuitive grasp of the situation and seem to sense in nonanalytic and nondeliberative ways the appropriate response to be made. They show fluid performance, as most people do when they no longer have to choose their words when speaking, or think about where to place their feet when walking... When things are going smoothly, however, experts rarely appear to be reflective about their performance (p. 6021).

Lack of reflection and the inability to articulate practice by classroom teachers carries into other areas such as values (Bishop 1999). There are serious implications associated with the observation that expert teachers lack reflective theories and are unable to clearly articulate their classroom practice. 'Until these underlying beliefs, attitudes and knowledge bases are meaningfully challenged, the change effort is in real danger of becoming yet another 'bandwagon' ' (Siemon, 1989, p. 254). Any successful professional development process requires that a teacher constructs a coherent personal teaching theory that will guide behaviour and reflection is fundamental in this transformation from a novice to an expert.

Another historical lesson that should be considered involves the definition of beliefs, an area so confused that Pajares (1992) was able to list over twenty aliases that have been used by researchers for discussing belief within their research. However it is possible to categorise research studies according to whether the definition of belief focuses upon a global statement or a specific behavioural belief statement. To appreciate the importance of this division it is necessary to consider Ajzen (1985, 1988) who provided an overview of the historical development of two research traditions dealing with attitudes and personality traits. The personality research tradition tried to explain behaviour in terms of underlying dispositions. For example people caught cheating and lying were regarded as being dishonest. "Personality research has revealed five general response tendencies that represent robust personality characteristics: sociability, agreeableness, conscientiousness, emotional stability, and culturedness" (p. 1). Now the trait concept was an attempt to explain these dispositions in greater detail using a multitude of personality traits that had

been identified. Ajzen defined a personality trait as "a characteristic of an individual that exerts pervasive influence on a broad range of trait-relevant responses" (p.2). Thus a subject's response to a stimulus was assumed to be a behavioural manifestation of an underlying trait. Early research failed to provide empirical evidence to support two important research implications. The first was that if traits were enduring behavioural dispositions then they should affect behaviour across a variety of situations. Thus a dishonest person could be expected to cheat in other situations such as tax claims, or to lie to friends, or to steal. However, findings failed to provide support for cross-situational consistency in behaviour.

The second implication was that the degree of correlation between global personality characteristics and the corresponding narrowly defined behaviours relevant to the trait in question would be high. An example would be to compare the results from an instrument such as a questionnaire designed to measure hostility with the aggressive and cooperative behaviour observed within a laboratory setting. Again the results from this type of research (Mann, 1959; Gibb, 1969) were poor. So poor that Mischel (1968) after reviewing the literature coined a term 'personality coefficient' to describe "the correlation between 0.20 and 0.30 which is found persistently when virtually any personality dimension inferred from a questionnaire is related to almost any conceivable external criterion involving responses sampled in a *different* medium - that is, not by another questionnaire" (p. 78). He pointed to the problem that behaviours used as trait indicators were highly specific to the particular context. Now these findings raise a number of important issues in the study of teacher beliefs.

Are beliefs highly specific to the particular context? This impinges on another area often associated with beliefs and that is the area of values. Values have been described as the deeply held beliefs that dispose a person to act in a certain way (Hill, 1991), and as deeper and more stable than beliefs (Seah, 1999). It is possible to see the attempt to explain behaviour in terms of underlying value system sharing similarities with the earlier attempts of using dispositions or traits. So if beliefs are highly specific to the particular context then it would seem prudent that the beliefs should be linked to the specific behaviour being examined in opposition to a more global definition.

In contrast to global belief studies, there are studies where beliefs are carefully linked to specific behaviours. In some studies, where attitude is a consideration, both belief strength and outcome evaluations are measured (Ajzen & Fishbein, 1980; Ajzen, 1988). Thus researchers gain a measure of both the teacher's beliefs about the consequences of performing an action (behavioural beliefs) and an evaluation of the consequences (outcome evaluation). Examples can be found in such diverse areas as voting behaviour (Fishbein, Ajzen & Hinkle, 1980), family planning (Fishbein, Jaccard, Davidson, Ajzen & Loken, 1980), consumer behaviour (Fishbein & Ajzen, 1980), weight reduction (Sejwacz, Fishbein & Ajzen, 1980), changing alcoholic behaviour (Fishbein, Ajzen & McArdle, 1980), smoking behaviour (Fishbein, 1982), infant feeding (Manstead, Proffitt & Smart, 1983), seatbelt use (Budd, North, & Spencer, 1984; Trafimow, & Fishbein, 1994), continuing education (Prior, 1990), driving violations (Parker, Manstead, Stradling, Reason, & Baxter, 1992), condom use (Chan, & Fishbein, 1993), work after childbirth (Granrose & Kaplan, 1994), teacher use of group work in secondary science (Lumpe, Czerniak, & Haney, 1998), teacher use of group work in primary mathematics (White, 2000a), teacher use of stencils in primary mathematics (White, 2000b), and teacher use of calculators in the primary

mathematics classroom (White, 1999; 2000c). These studies report medium to strong links between behaviour and belief and can demonstrate a causal relationship

Now consider the area of research into teaching patterns often designated as orientations, styles or modes of teaching that was very popular in the 1970s and 1980s and the historical resonance with teacher beliefs. Earlier studies into these teaching styles argued that teachers developed characteristic stable or fixed patterns of behaviour that may have been conscious and deliberately chosen, or have arisen from experience and may have been largely unconscious. Many researchers tended to represent these teaching styles upon a continuum with their theoretical opposites as end points (Kerlinger, 1967; Mosston, 1972; Lapp, Bender, Ellenwood, & John, 1975; Stallings, 1977), and some researchers used more than one continuum (Green, 1971; Brady, 1985; Ernest, 1989). An extreme case is presented by Joyce and Weil (1980) who conducted a very comprehensive study of teaching styles and set up 23 distinct models, which could also be grouped into four main classes. The aim of this type of research was either to present an overall structure for current teaching practice according to the researcher's theoretical presentation, or to categorize teachers according to a particular theoretical orientation. The assumptions were that all teachers could be located somewhere along the continuum and that knowing a teachers style would provide information concerning their specific classroom practices. It was hoped that certain styles would lead to greater student learning gains and thus the promotion of effective teaching styles would be the catalyst for teacher professional development.

This area of research failed to fulfil the hopes of supporters. There were many critics who challenged the assumptions and claims of the research. Bennett (1989) who comprehensively investigated the 1970s research upon learning styles was extremely critical of its inability to identify individual teacher activities or behaviours, which related to higher mathematics achievement. He stated that it was of little value in initiating improvements in teaching and the differences in scores between styles were often relatively slight, which severely limited the use of style as an explanatory variable. The classification of teaching behaviour by assigning a position upon the continuum did little to explain the basis of teacher classroom behaviour. What was lacking was a theory that considered how and why teachers behaved as they did, and the effects of that behaviour.

Some researchers are using beliefs as a basis for placing teachers upon a continuum. For example, Howard, Perry and Lindsay (1997) surveyed 249 secondary mathematics teachers in Sydney and constructed two different patterns of beliefs. The first was identified with the "transmission" profile where the transmission and verification of information was central and where memorization of rules and procedures were fundamental. The researchers reported that this group was larger in number than the opposing group called the "constructivist" profile. Here teacher beliefs indicated that students were capable of constructing their own mathematical knowledge in an atmosphere of negotiation and relevance. This study makes no attempt to study or examine the link between beliefs and action but does say that "further investigation comparing espoused beliefs of teachers and their enacted beliefs is required" (p. 237). A later study, Perry, Howard and Tracey (1999) studied the espoused beliefs of secondary mathematics coordinators from the perspective of a two-factor model of 'transmission' and 'child centred'. Now how applicable are Bennett's (1989) criticisms to these studies? For example, can these studies be used to identify individual teacher activities or behaviours, which relate to higher mathematics achievement? Consider the possibility of a teacher who

reports having more behaviourist beliefs than constructivist beliefs. How do we know which beliefs are linked to behaviour? It is possible that a teacher could use behavourist beliefs as a basis for action and constructivist beliefs for articulating practice or vice versa?. With this type of research we do not know the answers to these questions and while interesting, the value is questionable in terms of informing teacher classroom practice. "Improving teaching must be front and centre in efforts to improve students' learning" (Stigler & Hiebert, 1999, p. 3).

Conclusion

This paper attempted to use some lessons from the history of research to inform the current direction of research into teacher beliefs. It briefly identified some 'undiscussibles" in order to expose them to scrutiny. Ignoring the past and the lessons of history could be seen as a defensive routine that hinders progress and results in endless replication. The inability of research to assist classroom teachers to articulate their current classroom practices and values is detrimental to both individual growth and the mentoring of others, particularly pre-service teachers. Teachers would benefit from self-examination and a process that encourages reflection of their action theories and beliefs. Teacher educators must prepare their students for the classroom theories and behaviours that they are likely to meet in their professional experience periods and to cope with a range of teacher action theories and defensive routines. In helping pre-service teachers work towards practices that are consistent with the wider goals of the educational system it is crucial that they explore their own beliefs about classroom practice. It is the responsibility of researchers to provide the framework and the results that inform both belief and action. The gains in the future are intertwined with the gains of the past.

References

Ajzen, I. (1985). From intentions to action: A theory of planned behavior. In J. Kuhl & J. Beckmann (Eds.), *Action control: From cognition to behavior* (pp. 11-39). Berlin: Springer-Verlag.

Ajzen, I. (1988). *Attitudes, personality, and behaviour.* Milton Keynes, England: Open University Press.

Ajzen, I., & Fishbein, M. (1980). *Understanding attitudes and predicting social behavior.* Englewoods Cliffs, NJ: Prentice-Hall.

Argyris, C. (1991). Teaching smart people how to learn. *Harvard Business Review, 69* (3), 99-109.

Argyris, C. (1993). *Knowledge for action: A guide to overcoming barriers to organisational change.* San Francisco: Jossey-Bass Inc.

Argyris, C., & Schon, D. A. (1974). *Theory in action.* San Francisco: Jossey-Bass.

Argyris, C., & Schon, D. A. (1989). Participatory action research and action science compared: A commentary. *American Behavioural Scientist, 32*(5), 612-23.

Barkatsas, A. N. (2001). Secondary mathematics teachers' beleifs about mathematics assessment: A European perspective. In C. Vale, J. Horwood, & J. Roumeliotis (Eds.) *2001: A mathematical odyssey,* (pp.369-378). Brunswick Melb: M.A.V.

Bennett, N. (1989). Teaching and learning mathematics in the primary school. In P. Ernest (Ed.), *Mathematics teaching: The state of the art* (pp.107-118). Wiltshire, Great Britain: Falmer Press.

Berliner, A. (1994). Teacher tacit knowledge. In T. Husen & T. Postlethwaite (Eds). *The International encyclopedia of education (*pp. 6020-25) (2nd Ed) Oxford: Pergamon.

Bishop, A. J. (1999). Mathematics teaching and values education: An intersection in need of research. *Zentralblatt fuer Didaktik der Mathematik, 31*(1), 1-4.

Brady, L. (1985). *Models and methods of teaching.* Parramatta, Sydney: Prentice Hall.

Budd, R., North, D., & Spencer, C. (1984). Understanding seat belt use: A test of Bentler and Speckart's extension of the 'theory of reasoned action'. *European Journal of Social Psychology, 14,* 69-78.

Buzeika, A. (1996). Teachers' beliefs and practice: The chicken or the egg? In P.C. Clarkson (Ed),

Technology in mathematics education. (Proceedings of the 19th Conference of the Mathematics Education Research Group of Australasia, pp.93-100). Melbourne: University of Melbourne.

Chan, D. K-S., & Fishbein, M. (1993). Determinants of college women's intentions to tell their partners to use condoms. *Journal of Applied Social Psychology, 23* (18), 1455-1470.

Cobb, P., Wood, T., & Yackel, E. (1988). Curriculum and teacher development: psychological and anthropological perspectives. In E. Fennema, T. P. Carpenter, & S. J. Lamon, (Eds.), *Integrating research on teaching and learning' mathematics* (pp. 125-146). Madison WI: Wisconsin Centre for Educational Research.

Cooney, T. J. (1985). A beginning teacher's view of problem solving. *Journal for Research in Mathematics Education, 16*, 324-336.

Ernest, P. (1989). The knowledge, beliefs and attitudes of the mathematics teacher: A model. *Journal of Education for Teaching, 15*, 13-34.

Fishbein, M. (1982). Social psychological analysis of smoking behavior. In J. R. Eiser (Ed.), *Social psychology and behavioral medicine* (pp. 179-197). New York: John Wiley.

Fishbein, M., & Ajzen, I. (1980). Predicting and understanding consumer behaviour: Attitude-behavior correspondance. In I. Ajzen, & M. Fishbein, *Understanding attitudes and predicting social behavior* (pp. 148-172). Englewoods Cliffs, NJ: Prentice-Hall.

Fishbein, M., Ajzen, I., & McArdle, J. (1980). Changing the behaviour of alcoholics: Effects of persuasive communication. In I. Ajzen, & M. Fishbein, *Understanding attitudes and predicting social behavior* (pp. 217-242). Englewoods Cliffs, NJ: Prentice-Hall.

Fishbein, M., Ajzen, I., & Hinkle, R. (1980). Predicting and understanding voting in American elections: Effects of external variables. In I. Ajzen, & M. Fishbein, *Understanding attitudes and predicting social behavior* (pp. 173-195). Englewoods Cliffs, NJ: Prentice-Hall.

Fishbein, M., Jaccard, J., Davidson, A., Ajzen, I., & Loken, B. (1980). Predicting and understanding family planning behaviours: Beliefs, attitudes, and intentions . In I. Ajzen, & M. Fishbein, *Understanding attitudes and predicting social behavior* (pp. 130-147). Englewoods Cliffs, NJ: Prentice-Hall.

Gibb, C. A. (1969). Leadership. In G. Lindzey, & E. Aronson (Eds.), *Handbook of social psychology* (2nd ed., pp. 205-282). Reading, MA: Addison-Wesley.

Granrose, C. S., & Kaplan, E. (1994). Returning to work following childbirth: The relationship between intention and behavior. *Journal of Applied Social Psychology, 24* (10), 873-896.

Green, T. F. (1971). *The activities of teaching.* New York: McGraw-Hill.

Hill, B. V. (1991). *Values education in Australian schools.* Melbourne: ACER.

Howard, P., Perry, B., & Lindsay, M. (1997). Secondary mathematics teachers beliefs about learning and teaching mathematics. *People in mathematics education (*Proceedings of the Twentieth Annual Conference of the Mathematics Education Research Group of Australasia*).* Rotorua NZ: University of Waikato.

Joyce, B., & Weil, M. (1980). *Models of teaching.* NJ: Prentice Hall.

Keast, S. (2001). Teacher-led professional development: Identifying testable teacher beliefs. In M. A. Clements, H. H. Tairab & W. H. Yoong (Eds.) *Energising Science, Mathematics, and Technical Education for all* (pp. 147-155). Brunei: University Brunei Darussalam.

Kerlinger, F. N. (1967). Social attitudes and their critical referents. *Psychological Review, 74* (2), 110-122.

Lapp, D., Bender, H., Ellenwood, S., & John, M. (1975). *Teaching and learning. philosophical, psychological, curricular applications.* New York: MacMillan.

Lumpe, A. T., Czerniak, C. M., & Haney, J. J. (1998). Science teacher beliefs and intentions regarding the use of cooperative learning. *School Science and Mathematics, 98*(3), 123 - 135.

Manstead, A. S. R., Proffitt, C., & Smart, J. L. (1983). Predicting and understanding mothers' infant-feeding intentions and behaviors: Testing the theory of reasoned action. *Journal of Personality and Social Psychology, 44*, 657-671.

Mann, R. D. (1959). A review of the relationship between personality and performance in small groups. *Psychological Bulletin, 56*, 241-270.

Marton, F. (1986). Phenomenography - A research approach to investigating different understandings of reality. *Journal of Thought, 21* (3), 28-49.

McGalliard, W.A. Jr. (1983). *Selected factors in the conceptual systems of geometry teachers: Four case studies.* (Doctoral dissertation, University of Georgia). Dissertation Abstract International, 44, 1364A.

Mischel, W. (1968). *Personality and assessment.* New York: Wiley.

Mosston, M. (1972). *Teaching: From command to discovery.* Belmont, California: Wadsworth.

O'Hare, M. M. (1987). Career decision-making models: Espoused theory versus theory-in-use. *Journal of*

Counselling and Development, 65 (6), 301-03.

Pajares, M. F. (1992). Teacher's beliefs and educational research: Cleaning up a messy construct. *Review of Educational Research, 62* (3), 307-332.

Parker, D., Manstead, A., Stradling, S., Reason, J., & Baxter, J. (1992). Intention to commit driving violations: An application of the theory of Planned Behaviour. *Journal of Applied Psychology, 77* (1), 94-101.

Perry, R., Howard, P., & Tracey, D. (1999). Head mathematics teachers' beliefs about the learning and teaching of mathematics. *Mathematics Education Research Journal, 11* (1), 39-53.

Prior, B. W. (1990). Predicting and explaining intentions to participate in continuing education: An application of the theory of reasoned action. *Adult Education Quarterly, 40* (3), 146-157.

Schoenfeld, A. H. (1985). *Mathematical problem solving.* Orlando: Academic Press.

Seah, W. T. (1999). Values in Singapore and Victoria lower secondary mathematics textbooks: A preliminary study. In M. E. Clements & L. Y. Pak (Eds.), *Cultural and language aspects of science, mathematics and technical education: Proceedings of the 4th annual international conference of the department of science and mathematics education* (pp. 261-270). Brunei: Universiti Brunei Darussalam.

Sejwacz, D., Fishbein, M., & Ajzen, I. (1980). Predicting and understanding weight loss: Intentions, behaviours, and outcomes. In I. Ajzen, & M. Fishbein. *Understanding attitudes and predicting social behavior* (pp. 101-112). Englewoods Cliffs, New Jersey: Prentice-Hall.

Shield, M. J. (1999). The conflict between teachers' beliefs and classroom practice. In J. Truran, & K. Truran (Eds.) *Making the difference (*Proceedings of the twenty second annual conference of mathematics education research group of Australasia, pp.439-445). Adelaide: Adelaide University Press.

Siemon, D. E. (1989). Knowing and believing is seeing: A constructivist's perspective of change. In N. Ellerton, & M. Clements, *School mathematics: The challenge to change* (pp. 250-268). Geelong: Deakin University Press.

Stallings, J. (1977). *Learning to look. A handbook on classroom observation and teaching models.* Belmont, California: Wadsworth.

Stigler, J. W., & Hiebert, J. (1999). *The teaching gap.* NY: Free Press

Thompson, A. (1992). Teachers' beliefs and conceptions: A synthesis of the research. In D. A. Grouws (Ed.), *Handbook of research on mathematics teaching and learning* (pp. 127-146). Reston: NCTM.

Trafimow, D., & Fishbein, M. (1994). The importance of risk in determining the extent to which attitudes affect intentions to wear seat belts. *Journal of Applied Social Psychology, 24* (1), 1-11.

White, A. L. (1999). Teacher action theories towards student use of calculators in upper primary mathematics classrooms. In M. A. Clements, & L. Y. Pak (Eds.) *Cultural and language aspects of Science, Mathematics, and Technical Education: Proceedings of the Fourth Annual International Conference of Science and Mathematics Education* (pp.308-317). Brunei: University Brunei Darussalam.

White, A. L. (2000a). The articulation of practice: Teacher action theories and the use of group work in upper primary mathematics classrooms. In M. A. Clements, H. H. Tairab & W. H. Yoong (Eds.)*Science, mathematics, and technical education in the 20th and 21st centuries* (pp.227-235). Brunei: University Brunei Darussalam.

White, A. L. (2000b). The use of teacher action theories in the articulation of practice: The use of stencils in the upper primary classroom. In J. Bana, & A, Chapman (Eds.) *Mathematics Education beyond 2000* (Proceedings of the Twenty- third Annual Conference of the Mathematics Education Research Group of Australasia pp.648-55). Perth: MERGA.

White, A. L. (2000c). The use articulation of practice: Teacher action theories and student use of calculators in upper NSW primary classrooms. *Paper presented at the Annual Conference of the Australian Association for Research in Education.* Sydney.