

A COMPARATIVE ANALYSIS OF RESEARCH QUESTIONS, METHODS, AND METHODOLOGIES IN MATHEMATICS EDUCATION: 1979 AND 1993

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This paper reports on a comparative analysis of research presented to the 1979 and 1993 MERGA Conferences. Two main issues are considered: the nature of research methods and methodologies utilised by researchers; the content focus of principal questions made the subject of research. In considering the first of these, papers were stratified by research methodology (positivist, interpretivist, critical), data type (quantitative, qualitative), and research method (experiment, survey, clinical interview, discourse analysis, etc). Analysis of the data indicated that whilst the positivist paradigm predominated in both conferences, a significant switch to qualitative methods and a diversification of methodologies was observed in 1993. In addressing the second main issue, dominant research questions for each conference were identified in terms of subject domain clusters. Methodology used in this task involved the construction of a subject matter matrix, within which each submitted paper was allocated to a single cell. Papers were thus stratified by two variables accounting for educational agency (student, teacher, classroom, researcher) and content (knowledge, beliefs/attitudes, context). Major findings were an increased emphasis in 1993 on the student vis a vis teacher, and a switch of emphasis from beliefs/attitudes to the study of contextual domains of education. The paper concludes with a discussion of the limitations of the methodology used in this study, and an identification and discussion of principal findings.

The 1993 conference of the Mathematics Education Research Group of Australasia is the Sixteenth Annual Conference of the organisation and the second time the conference is held in Brisbane, the first being the Third Annual Conference held in 1979. During the fourteen years separating the two conferences, mathematics education research in Australasia has witnessed significant changes in the socio-political as well as theoretical contexts. Watson and Atweh (1992) for instance, in identifying a range of recent factors influencing mathematics education research, mentioned increases in research funding and numbers of researchers, and the growing diversity of international influences. The main aim of this paper is to discuss the major differences in mathematics education research reported at the two MERGA Brisbane conferences. This paper has two purposes: (i) to identify the foci of research interests during the 1979 and 1993 MERGA conferences and (ii) to identify major shifts in research interests between the two conferences. We will attempt to achieve these purposes by considering, firstly, the Plenary sessions and the Special Interest Groups at both conferences, secondly, the methods and methodologies used by authors of these papers, and thirdly, the subject matter analysis of the papers submitted at both conferences.

PLENARIES AND SPECIAL INTEREST GROUPS

The proceedings of the 1979 conference (Booker, 1979; Atweh, Booker, Irons & Jones, 1979) included 24 papers, while 93 papers were submitted to 1993 conference, representing an increase of 387%. There was one Plenary Address at the 1979 conference and five at the 1993 conference. The plenary at the 1979 conference was introspective dealing with the aims and future directions of MERGA. The plenaries at the 1993 conference dealt with research perspectives around the theme of the conference: Contexts in Mathematics Education. Two of the speakers at the 1993 conference are from overseas, representing the increasing international orientation of the organisation.

Special Interest Groups (SIGs) at the annual conference provide a reliable indication the major trends and interests of research. It is of interest to note that all but one of the SIGs at the 1979 has either been discontinued or have

undergone changes in focus and/or name within the last fourteen years. The SIG Mathematics Learning in Early Childhood has changed into Number SIG which convened up to the 1992 conference. The SIG on Language, Reading and Mathematics has changed its title to Language and Mathematics and has remained active during the fourteen years. The SIG Attitudes to Mathematics and Diagnosis and Remediation have been discontinued at MERGA conferences. The SIG on Sex Differences in Learning has changed to Gender and Mathematics, and in the 1992 conference became the Social Justice SIG. The SIG on Problem Solving is still meeting under the same name. In addition to the above SIGs new groups have formed since the 1979 conference on Algebra, Space and Geometry, Ethnomathematics, Calculators and Computers, and on Adult Learner.

RESEARCH METHODS AND METHODOLOGIES

In this section we will consider the developments in methodologies and research methods used by Australasian mathematics educators in 1979 and 1993. A number of preliminary comments are needed. First, we accept the distinction made by Guba and Lincoln (1988) between methodology and methods of research. Methodologies refer to overarching conceptual paradigms used in framing a study, whereas methods refer merely to tools for research. Different methodologies may employ the same methods. Secondly, as Linn (1986) notes, although qualitative and quantitative alternatives in research are sometimes identified with paradigms, this view over-simplifies the issues concerned. Accordingly, in this paper, we regard the qualitative/quantitative choice as merely a matter concerning the type of data a study involves. Thirdly, whilst broad agreement may exist concerning the nature and methods appropriate to the traditional scientific paradigm for educational research, no such agreement exists for alternative paradigms. Each of the following labels, for instance, refers to various aspects of alternative models: naturalistic, interpretive, intuitive, subjective, ethnographic, field research. These terms may overlap with each other, but each refers to a distinct set of characteristics, hence each would lead to different classification of research. This section will deal with research paradigms (methodologies) and research methods separately.

Research Methodologies

Carr and Kemmis (1986) discuss three paradigms for educational research rather than two. The first paradigm, the positivist, involving a scientific approach, is based on the belief that human action is governed by "law-like relationships" (Candy, 1989, p2) which can be discovered by careful manipulation and measurement of variables. Research in the second paradigm, the interpretive, seeks to "explain how people attribute meaning to their circumstances, and how they develop and make use of rules which govern their behaviour" (p2). Lastly, Candy identified a "schism" within the interpretive paradigm which has given rise to a third alternative, namely the critical paradigm. This approach is based on the belief that "human beings do not live in worlds entirely their own devising and that people generally are subject to influences and pressures that share their attitudes and perceptions and yet of which they are often unaware" (p2). Research using this paradigm attempts to analyse the historical context and social interactions that give rise to meaning and behaviour.

Using Candy's definitions then, all of the papers from the 1979 conference that deal with empirical research fall under the positivist perspective. The papers in the 1993 conference, however, show a greater diversity. Although the majority are still in the positivist approach as defined above, 60 papers (65%), about 10 papers (11%) could be classified as interpretive, and 6 (6.5%) as critical. The remainder of the papers, 16 or 16%, could not be classified because they consist of reviews of literature, position papers or unfocussed research papers. In summary, alternative paradigms for research are in evidence within the mathematics education research community, although they are not predominant.

Research Methods

As noted above, the labels qualitative/quantitative are taken here to refer to a type of data rather than as paradigms for research. It is of interest to compare their relative use within the three paradigms outlined above. Table 1 provides such a comparison. It is of interest to note that while the majority of studies in the interpretive and the critical paradigms are qualitative, studies within the positivist approach tend to be divided between the two types of data. Further, there is a marked shift between 1979 and 1993 from studies using quantitative data towards those using qualitative data.

Table 1: Number(Percentages) of papers at the 1979 and 1993 conferences by data and paradigm type.

	Positivist	Interpretive	Critical
Quantitative.	13(81.3) 29(48.3)	0(0) 2(20)	0(0) 0(0)
Qualitative.	3(18.7) 27(45)	0(0) 7(70)	0(0) 6(100)
BOTH	0(0) 4(6.7)	0(0) 1(10)	0(0) 0(0)

Table 2 below show numbers and percentages of papers classified according to their research method. In the vast majority of cases the papers themselves identify the method that they use. In those cases, the author classification is used; whether or not we agreed with their classification.

Table 2: Numbers(Percentages) of papers in the 1979 and 1993 conferences by research method type.

Experimental Design	Test Development	Survey	Action Research/ Teaching Experiment/ Program evaluation
5(21) 9(9.8)	2(8) 0(0)	4(16.6) 19(20.6)	3*(12.5) 7(7.6)

Classroom Observation	Ethnography / Case study	Clinical Interview	Critical Discourse Analysis	Non-Analytic
1(4) 2(2.2)	0(0) 7(7.6)	1(4) 27(29.3)	0(0) 6(6.5)	8(33) 15(16.3)

* Two papers are program description with little reflection

A number of patterns are of interest from this data. First, in the 1979 conference a large number of papers, about 32% did not provide empirical data. This category of paper was reduced by half in the 1993 conference. Second, there has been a noticeable decrease in the percentage of studies using experimental designs and test development research reported at the 1993 conference and a significant increase in the studies using clinical interviews. Although it might appear that the number of action research/teaching experiment type research has decreased, a closer examination of the papers, however, has revealed a shift from program exposition in 1979 to critical studies involving sophisticated theory and procedures in 1993. Thirdly, the new categories of ethnography, case study and critical analysis have emerged since the 1979 conference.

ANALYSIS OF RESEARCH SUBJECT MATTER

The purpose of this analysis was to obtain an overall view of the subject matter concerns represented by submitted papers to each of the conferences under review. Identification and comparison of lines of research activity within and between the target years may thus be facilitated. Data was stratified by 4 variables representing educational agency (Student, Teacher, Classroom, Researcher); and by 3 content variables (Knowledge, Beliefs/Attitudes, Context) representing critical aspects in the 'life' of the agent. Allocations between content variables were made with reference to the following definitions: **Knowledge**, consisting of conceptual knowledge (content knowledge), procedural knowledge (specific skills, higher order processes) and accessed by the user either tacitly or explicitly; **Beliefs/Attitudes**, involving statements which are taken-as-true by the agent either tacitly or explicitly (Clark and Peterson, 1986; Peterson, Fennema, Carpenter, Loef, 1989); **Context**, thought of as a domain of influence beyond mathematical or pedagogic knowledge narrowly defined.

Utilising these stratifications, a matrix (4x3) was constructed. Each paper was then allocated to a single cell position, and this was taken to represent the paper's chief focus of research involvement within the matrix.

Data was further stratified within matrix cells. In the case of the Teacher/Knowledge cell, initial use was made of Shulman's taxonomy (1986, 1987) of the teacher knowledge base. Salient elements in this were adapted in order

to construct the following 5 sub-stratifications:

- **Mathematical content knowledge**
- **Pedagogic knowledge:** Knowledge of teaching strategies, management, organisation *independent* of content/topic.
- **Pedagogic content knowledge:** Knowledge of teaching strategies, management, organisation *dependent* on content/topic.
- **Curriculum knowledge:** Knowledge of materials and programmes, including technologies, assessment instruments *etc.*
- **Professional development:** Development of teacher knowledge.

Of the papers reviewed, 1 paper in 1979 and 2 papers in 1993 were excluded from this analysis as they were peripherally related to research questions in mathematics education.

Subject matter cluster analysis results are set out in Table 3 below.

Table 3: Number (percentage) of papers in 1979 and 1993 with matrix showing subject matter clustering.

	KNOWLEDGE	BELIEFS/ ATTITUDES/	CONTEXT	TOTAL
TEACHER	9(37.5) 34(37.4)	4(16.7) 6(6.6)	0(0) 1(1.1)	13(54.2) 41(45.1)
STUDENT	6(25.0) 31(34.1)	2(8.3) 4(4.4)	1(4.2) 6(6.6)	9(37.5) 41(45.1)
CLASSROOM	-	-	0(0) 3(3.3)	0(0) 3(3.3)
RESEARCHER	1(4.2) 4(4.4)	-	-	1(4.2) 4(4.4)
TOTAL	16(66.7) 69(75.8)	6(25.0) 10(11.0)	1(4.2) 10(11.0)	

These results indicate that research focus on the educational agent variables of Teacher and Student claimed the principal attention of about 90 percent of studies in both 1979 and 1993. However, in 1979, focus on the teacher (54.2% of total) was greater than for the student (37.5%), whereas in 1993 the share between teacher and student was exactly even. Classroom and Research variables also claimed more attention in 1993. Analysis of content variables shows that focus on knowledge predominated in both conferences, although in 1993 it received increased attention compared to 1979 (66.7% versus 75.8%). On the other hand, there has been a marked switch in focus between the Belief/Attitude and Context variables: Interest in the former cell declined from 25% to 11%; interest in the latter rose from 4.2% to 11%. Studies focussing on the Context variable have involved investigations of gender, ethnicity, institutional frameworks and other factors within the social domain.

Tables 4a and 4b below sets out data relating to the sub-stratification of the Teacher/Knowledge and Student/Knowledge cells.

Table 4a: Number (percentage) of papers in 1979 and 1993 showing Teacher/Knowledge cell sub-stratifications.

Mathematical knowledge	Pedagogic knowledge	Pedagogic content knowledge	Curriculum knowledge	Professional development
0(0) 1(1.1)	2(8.3) 9(9.9)	3(12.5) 9(9.9)	4(16.7) 8(8.8)	0(0) 7(7.7)

Table 4b Number (percentage) of papers in 1979 and 1993 showing Student/Knowledge cell sub-stratifications.

Mathematical concepts	Mathematical processes	Language
3(12.5) 18(19.8)	3(12.5) 11(12.1)	1(4.2) 2(2.2)

The most notable feature in the Teacher/Knowledge cell (Table 4a) is the rise of interest in a focus on professional development. In the Student/Knowledge cell (Table 4b) an increased focus on student conceptual domains is observed (25% versus 34.1%). In contrast to 1979, attention is more diversely spread across the content domains of arithmetic, algebra, calculus, geometry, and statistics. Studies in problem solving in 1993 show a highly focussed utilisation of the relevant theories of cognition compared with those in 1979.

DISCUSSION AND CONCLUSIONS

In considering the results of this paper a number of important qualifications need to be kept in mind. Firstly, this has not been a longitudinal study of mathematics education research. Data, covering two years only, are considered insufficient to indicate research trends. Our more modest aim has been to closely study two temporally separated 'snapshots' of research in order to draw out perceived differences and similarities. A second qualification involves the concern that our methodology may have distorted or in some cases obscured notable themes within the bodies of research studied. For instance, the subject matter matrix used to obtain a view of principal research foci does not adequately deal with instances where papers have dual concerns, or where no single concern is easily determined. We are conscious that emergent themes may have suffered the most: for example, tertiary studies in mathematics education has emerged as a theme in 1993, although this has not been noted in our analysis above. Similarly, there is evidence for the emergence of concern for themes of difference such as gender, ethnicity, social class *etc.* In our third area of concern, we note that our categories of analysis have largely been drawn from the research literature, rather than the data themselves. Arising from this, the stability of the taxonomies in relation to the bodies of research studied in this paper, may need to be more thoroughly considered. Notwithstanding these qualifications, however, we believe significant conclusions concerning outlines of research and their comparison in 1979 and 1993 are possible, and we briefly summarise these below.

First, concerning research methodologies, we note that although the positivist paradigm remains predominant in both conferences, the alternative interpretivist and critical paradigms have made a substantial contribution to the 1993 programme. A second important observation indicates an increased reliance on qualitative over quantitative research methods between the years studied; we caution, however, that this observation, by itself, does not imply a switch away from the positivist paradigm. We note that although there has been a marked reduction in the use of experimental design, surveys and clinical interviews remain the most widely used methods in research. The ratio of descriptive or non-analytical studies is also markedly less in 1993.

Turning to consider subject matter of research questions pursued by researchers, our first conclusion is that for both conferences the attention of most studies is mainly focussed on teachers and students. In 1979, however, more studies focussed on the teacher than the student, whereas conversely, in 1993, emphasis fell more heavily on the student. We note that this finding is consistent with a shift in ethos within the mathematics education community towards obtaining a more even balance between these particular agents of the educational process. Secondly, there are signs of a movement to reconceptualise research beyond the usual teacher/student dichotomy; in this regard classroom interaction has emerged as a unit for investigation in its own right. Thirdly, we found that there has been a significant switch of focus from the study of beliefs/attitudes, toward a study of contexts and with this, as noted above, a study of relations of difference. We consider this a significant finding, and note it is consistent both with the known strengths of the interpretivist and critical paradigms and an apparent shift toward the increased utilisation of these paradigms in mathematics education research, as has been noted above. Another important conclusion is the strong concern for professional development in the 1993 conference, and this is also consistent with shifting emphases in policy and needs recently identified by the teaching profession at large. We note in closing that there has also been a marked increase in the range and level of theoretical involvements in the studies reported in the 1993 conference. In this connection, it would be informative to any future investigation into research trends to analyse the depth and variety of theoretical concerns accessed by researchers in their studies.

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