The Australian Journal of
INDIGENOUS EDUCATION

AN ENRICHED MATHEMATICAL PROGRAM FOR YOUNG ABORIGINAL CHILDREN

* Jan Currie
Barry Kissane
Harriett Pears

ABSTRACT

This paper provides some early results on a project designed to improve Aboriginal children's performance in mathematics, starting from their earliest introduction to number work. It explores the use of an enriched mathematics environment that minimally conflicts with traditional Aboriginal learning styles. The study is concerned with evaluating the effectiveness of a program intervention in remote Aboriginal schools, based on the results of pre- and post-interviews given to children at eight different schools in Western Australia at the beginning and end of 1989 and 1990. Comparison data with those for children at other schools are provided in this paper. The data derive from interviews with young children, and provide evidence on their performance in several key areas of early mathematics. Schools were categorized into three groups: White middle class; town Aboriginal and working class; and remote Aboriginal. The White middle class schools had the highest performance, followed by the town Aboriginal and White working class schools and the remote Aboriginal schools. There was a rather consistent gain in mean scores for most schools of around four points over the course of the first year so that existing differences between schools at the beginning of the year were still evident at the end of the year. At this stage it is difficult to conclude whether the intervention program has improved mathematics achievement for this group of remote Aboriginal children. There is at least no evidence of 'progressive retardation', which describes the current situation where Aboriginal children fall farther behind as they progress through school.

All authors are from the School of Education, Murdoch University. Jan Currie is a Senior Lecturer who has worked with the Warralong Community on introducing Montessori & Mortensen mathematics since 1984. Barry Kissane is a Lecturer in mathematics and computer education, and has also worked with the Warralong Community. Harriet Pears was the Graduate Research Assistant with this project.

One of the most distrubing aspects of the schooling of Aboriginal children in Western Australia is their level of performance in mathematics. There is a gross under-representation of Aborigines in mathematics classes in the upper secondary school level in Australian schools and Aborigines perform poorly in mathematics compared with non-Aborigines. In 1990 in Western Australia, the overall school retention rate of Aboriginal students from Year 8 to Year 12 was 12.7 per cent compared with the retention rate among all students which was approximately 60 per cent (Ministry of Education, personal communication). Very few Aboriginal students proceed to higher education. In Western Australia in 1988, according to the Higher Education Status Report (1988), there were 142 Aboriginal students enrolled in award courses in the four institutions with the majority enrolled in Arts and Education at Edith Cowan University. While approximately 2.4 percent of the general population was enrolled in 1988 in award courses, only 0.4 percent of the Aboriginal population was enrolled in such courses (Ministry of Education, 1988).

Hunting and Whitely (1983), in a review of research related to mathematics achievement of Aboriginal children, concluded that "European contact is a major factor for success with tests of cognitive ability, suggesting that European-type enrichment of the Aboriginal child's environment will lead to measurable gains in cognitive functioning and in mathematics achievement". Aboriginal children from more traditionally-oriented communities performed poorly on tests of 'classificatory ability' (de Lacey, 1970); 'verbal intelligence and operational thinking' (de Lacey, 1971); 'conservation of quantity, weight, volume, length, area and number' (de Lemos, 1969); 'conservation of quantity and weight, classification, seriation and horizontality' (Seagrim and Lendon, 1980). However, Aboriginal children from more traditionally-oriented communities performed better than 'non-traditional Aboriginal children who, in turn, performed better than 'White Australian' children on tasks requiring visual spatial memorisation strategies (Kearins, 1976 and 1981).

Studies with American Indians show that their achievement is lower than other groups in most content area. For example, Cheek (1984) reported that "the average mathematical achievement level of Native American students are extremely low in comparison with students of other ethnic groups"

(1984,p1). Brod's (1979) Mississippi study confirmed a conclusion reached by the Senate Subcommittee on Indian Education (1969) ten years earlier: American Indian children typically fall farther and farther behind national norms as they progress through school. This phenomenon has been designated as 'progressive retardation' (Coombs, 1970).

To our knowledge, there is no study that corroborates Kearins' work among American Indians showing superior visual spatial skills. However, one study (Scott, 1983) shows an interesting difference between Pueblo Indian and Anglo students who were studying to be elementary school teachers. She found that Anglos scored higher on arithmetic and algebra items while Pueblos scored higher on measurement and geometry items. The measurement items appeared to relate more to real world experience while the arithmetic and algebra items were highly symbolic and could be done by rote manipulation. Her advice to teachers was to provide basic mathematics instruction that related computational skill to real world situations.

A number of researchers have tried to determine the causes for the low achievement of some ethnic groups. In a recent book edited by Cocking and Mestre (1988), the authors try to disentangle the various linguistic and cultural influences on learning mathematics. Myers and Milne (1988) concluded that "although the research findings are diverse, in nearly every study one language minority group or another is shown to demonstrate school performance below that of native English speakers" (p 259).

Several writers in this same volume (Cocking and Chipman, 1988; Leap, 1988; and Myers and Milne, 1988) noted that American Indian and Hispanic children fall consistently behind in mathematics achievement: the other non-English groups such as the Italians, Germans and Chinese often achieve more highly in mathematics than native speakers (Myers and Milne, 1998). In a large cross-national study, Stigler et al. (1987) reported that "the mean scores of American kindergarten children were below those of Japanese children. By first grade, American children's scores were significantly below those of both Japanese and Chinese children and by fifth grade, the differences were even greater" (p 1272). One of their conclusions was that American children spend much less time on mathematics than

children in Japan and Taiwan and have less instruction directly from their teachers. In a study with the intention of exposing kindergarteners to more mathematics than is typically the case, the University of Chicago School Mathematics Project (Hedges et al., 1988) found that even though urban children began the school year with lower skills, by the end of the school year they had essentially caught up with their suburban counterparts.

In contrast to the situation with American Indian children for whom the performance "gap" widens as higher grade levels are reached (Leap, 1988), Dawe (1983) reported that Asian children showed consistent and marked improvement in cognitive abilities with years of schooling and exposure to British culture. This may suggest that there is some disadvantage with non-English speaking children when they enter school but as they progress through the schooling system their cognitive skills reach a similar level to English-speaking children. This was confirmed in a study by Butler and Marsh (1986) who tested English-speaking and non-English speaking children in Australia in Year 6. They found that the two groups did not differ in mathematics achievement.

Mayeske et al. (1973 as reported in Myers and Milne, 1988) re-analysed Coleman's Equality of Educational Opportunity data and tested language in the home against a broad cluster of other family background factors (including parental education, occupation, income, family stability and family child-rearing process). The authors concluded that a large relationship between language and achievement "is *not* present, and that the relationship that does exist can be explained largely by differences among students in socio-economic status" (p80).

This would suggest that the low achievement found among indigenous groups or those that are the most oppressed in society (Blacks and Hispanics) is not necessarily caused by language but by other cultural factors. Nevertheless, the evidence on the linguistic influences remains equivocal because often the more exacting variables (such as proficiency in home language and in English) are not included in these studies. As a result, researchers continue to experiment with bilingual mathematics classes to determine if learning mathematics in one's own language improves achievement. Schindler and Davison (1985) reported that

that mathematical meaning can be gained in one's own living environment. Several of the studies also show that by giving greater attention to teaching mathematics, using more manipulatives and having more time on task, children can improve their performance in mathematics quite significantly.

THE STUDY

This paper focuses on the mathematical performance of young Aboriginal children not attending 'European' government schools. The particular group studied attend the Strelley Community School, located on pastoral leases in the Pilbara region of Western Australia. Beginning in 1989 an 'enriched' mathematics environment was provided for the Aboriginal children to try to improve their mathematics achievement. Then pre- and post-interviews were given at the beginning and end of each of the school years in 1989 and 1990. For comparison purposes, children in five other schools were also interviewed about the same time.

Remote Aboriginal School

Strelley was the first Aboriginal Independent School to be established in Western Australia in 1976. (There are ten independent schools now in existence serving Aboriginal communities in Western Australia as diverse as those living in suburban Perth to the more remote areas near the Great Sandy Desert.) The term "Strelley Community School" is an umbrella term for a number of smaller schools run by Aboriginal groups located approximately 160 km east of Port Hedland, a small coastal town with a population around 12,000. Port Hedland in turn is approximately 2000 kms from Perth, the capital city of Western Australia.

John and Gwen Bucknall, who have been associated with Strelley for more than twelve years, recently conducted a Review of Aboriginal Independent Schools in Western Australia (1988) and identified the following aims of the Strelley School:

- Teach adults and children basic literacy and numeracy skills in both the vernacular and English.
- Encourage and assist in the future development and enrichment of the vernacular language as an essential component in maintaining feelings of worth and esteem.

- Create a framework within which Aboriginal Teachers will increasingly assume the roles currently filled by White teachers while recognizing the obvious need to allow for the full development of Aboriginal learning styles and contexts.

- Effectively develop skills programs based on the future economic development of the group and in particular pastoral, agricultural and small scale industrial, administrative, managerial and technical skills.

The students in these schools gain initial literacy in Nyangumarta, their first language, and gradually they are introduced to English as a second language. Nyangumarta is taught by Aboriginal teachers who have been trained on site over a number of years. The Aboriginal teachers use Nyangumarta to assist the children in understanding the mathematics concepts which are initially introduced in English.

The Strelley Schools are ideal settings to try to experiment with a new kind of mathematics program. The Aboriginal language takes precedence in the schools and the non-Aboriginal teachers are being encouraged to continually negotiate with the Aboriginal teachers about the nature of the curriculum. To create the foundation for a meaningful mathematics program, Graham (1984) suggests that Aboriginal and non-Aboriginal teachers have to engage in dialogues about mathematical meanings. This should enable teachers to understand how Aboriginal children perceive and talk about their world. From this base, non-Aboriginal teachers can devise experiences from local Aboriginal content before taking the children into western mathematical content which is unknown to them in their environment.

The "Enriched" Program

It is within this context that Murdoch researchers were invited to extend and enhance the mathematics curriculum. After considerable discussion the Strelley School Committee of Aboriginal elders together with the teachers decided to introduce a new mathematics program that combined Montessori and Mortensen mathematics equipment in one of their schools (see Note 1). Murdoch University researchers felt that this

kind of program would create a mathematically rich environment which would minimally conflict with Aboriginal learning styles. It would allow children to move from the concrete to the abstract and from the known to the unknown. Mortensen mathematics was also chosen because it was an extension of Montessori mathematics and it provided a practical, hands-on approach (with material that was considerably less expensive). The materials also incorporated the critical concept of place value that underpins western numeration.

It was felt that both of these programs might offer an effective bridge between Aboriginal learning styles and the more formal western learning approach. Both the Montessori and Mortensen mathematical approaches rely very heavily on didactic materials with the Montessori materials more useful for the very young children and the Mortensen materials more useful for children from about 7 years of age. All the Strelley schools now use the Mortensen materials but only one of the schools has acquired the Montessori materials. In addition to these two programs, the researchers gave workshops for teachers on aspects of teaching space, number, measurement and on the use of calculators. An emphasis of all the workshops was the use of a 'do, talk and record' model of teaching and learning mathematics.

Sample Schools

Based on the evidence of previous research which found that the degree of contact children have with the mathematico-technological world will affect their level of mathematical performance, schools were selected to represent different geographical locations and different socioeconomic areas. The schools were not chosen at random; rather, they were conveniently located. In each school twelve 5 and 6 year old children, both boys and girls were selected for interviewing in 1989 and a slightly larger number of 6 and 7 year olds were interviewed in 1990.

The two convenient locations for choosing schools were Port Hedland and Perth. In addition to location, the Aboriginal students in two Port Hedland schools were interviewed because there was a high probability that the children in these schools would be of the same language and family groupings as those in the Strelley communities. However,

their life in a rural town would be more conducive to introducing them to 'western' concepts in mathematics. Three schools in Perth were chosen to represent a working class school, a middle class school and a middle class school with a Montessori program. Principals of the three schools were approached: a private Montessori school, located in a middle class suburb, a state school located in a middle class suburb, and another state school located in a working class suburb. A selection of 'typical' children, who were neither recognised as especially bright nor as especially slow in terms of their development was made by the teachers concerned, rather than by a random procedure; nonetheless, in each case it was felt by the teachers that the children were reasonably representative of their respective groups. One of the schools (a school in Perth which had Aboriginal children) was dropped after the first year because only a few children were available to be interviewed twice.

In this paper the Strelley schools (Mijiji Maya and Lalla Rook and Warralong) are grouped together even though slightly different programs operated at each of the schools. They represent children in a remote desert community with little contact with mathematics outside of school. The two middle class schools are similar in terms of their clientele. The children's parents are mainly in administrative and professional occupations. They live in comfortable suburbs in metropolitan Perth. One of the schools was a private Montessori school and the other a state school which was well resourced. The Other working class category looks like an odd mixture at first since we combined rural Aboriginal children with White children living in a working class suburb of metropolitan Perth. The Aboriginal children were attending a government school in a coastal town and were mainly from working class backgrounds. The White children were in a state school that was categorised as a 'priority' school because the children came from 'disadvantaged' backgrounds. A substantial percentage of the children were in families supported by Social Security, their parents unemployed. Some might describe this group as part of the 'underclass' of Perth and similar to the backgrounds of many of the Aboriginal children interviewed.

Besides the 'cultural' reasons for categorising the children into these three groups, there were also statistical reasons. When we analysed the scores after the first inter-

viewing time, we discovered that the three groups were placed on a continuum such that the Middle Class schools grouped together, the Other Working Class schools came next and the Strelley schools followed in three clusters. Table 1 shows the actual sample sizes used in the data analysis by school groups. The figures in bold text indicate sequential interviewing on four occasions and the figures in brackets indicate the children interviewed for the first and second times on the third and fourth occasions.

Table 1: Sample sizes for the three school groups on four occasions.

Time	White Middle Class	Other Work Class	Strelley schools	Totals
1	**21**	**32**	**18**	**71**
2	**20**	**30**	**18**	**68**
3	**18** (43)	**17** (38)	**9** (8)	**44** (89)
4	**18** (40)	**14** (28)	**8** (6)	**40** (74)

The reasons for the changes in the sample numbers are as follows: In 1989 we began with 71 children for Time 1; this was reduced by natural attrition to 68 for Time 2. In 1990 we decided we needed to add children to our sample to make it more viable. At Time 3, 133 children were interviewed, most for the first time (numbers above in parenthesis); by Time 4, 114 children were interviewed, some for the fourth time and most for the second time (numbers above in parenthesis). Altogether 160 children were interviewed once; 142 interviewed twice; 44 interviewed three times and 40 interviewed four times.

Interview Schedule

To assess the levels of performance of the Aboriginal and comparison children, an interview schedule was constructed. The schedule was initially based on work conducted by The University of Chicago School Mathematics Project in their evaluation of Kindergarten Everyday Mathematics (Hedges *et al.*, 1987). It was originally hoped that some comparisons could be made between the performance of young Western Australian students and students of similar ages in the Chicago study, especially since the latter had involved a number of groups of students from minority cultures.

A major feature of the Chicago work was that it involved face to face interviews with each student, rather than a more formal written process. This seemed to be more likely than a written test to lead to valid information from young students, especially those who could not yet read with confidence. However, on closer inspection, the Chicago interview was inappropriate for the present purposes in some important respects. In the first place, it did not involve the use of physical materials, and it was felt that this would be inconsistent with classroom practices in Western Australia, especially those to be developed at the Strelley School. Secondly, the interview was rather short, and did not encompass a sufficiently wide range of tasks to adequately reflect the Western Australian curricula. Thirdly, it did not pay sufficient attention to how students arrived at their answers, and it was hoped that some diagnostic information might be obtained through that means. Consequently, a new interview schedule was developed for the present study.

To get a comprehensive picture of mathematical performance of the children, clusters of interview questions were devised in the following areas:

QUANTIFICATION

These questions assessed whether students could count small sets of objects,how they went about doing so, and examined how far they could count. Attention was paid to how children counted (e.g. whether or not they touched each object when counting) as well as how accurately they did so.

OPERATIONS

These questions were concerned with whether children realised when addition and subtraction were involved in practical situations. The subtraction questions dealt with each of the three ways of thinking about subtraction: taking away, comparison and complementary addition.

READING

Questions determined whether or not children could recognize and read numbers of one, two and three digits, and whether they understood place value with two-digit numbers.

PATTERNS

Both number and spatial patterns were used to see whether children could detect, describe and use sequential patterns.

SHAPES

These questions determined whether students knew the conventional names for the two-dimensional shapes that were used to make the spatial patterns.

MEASUREMENT

Each of length, mass and money were dealt with in questions concerned with the basic concepts.

To accompany the interview schedule, a kit of materials was developed, consisting mainly of materials commonly found in schools (e.g. blocks) or the natural environment (e.g. stones), and a coding sheet was devised The interview was untimed, in the sense that it was intended that children could take as long as they felt necessary to answer the questions. In fact, early administrations suggested that most children completed the interview as well as they could within 20 minutes, and no children required more than 30 minutes. The interview schedule was translated into Nyangumarta and given by Nyangumarta teachers in the Strelley Community Schools. In the other settings it was given by the researchers in English.

RESULTS

Based on a Rasch analysis (Wright & Stone, 1979) of the responses of 71 children to these items, it was decided to add scores on the 26 items to get a single total score, rather than confine the analysis to each of the separate sub-scales. Table 2 below indicates the means and standard deviations of the total scores of the entire group of students on the four and two interviewing occasions. The figures in bold text indicate the sequential interviewing on four occasions. Those who were first interviewed in March 1989 are seen as a distinct group from those who were first interviewed in April 1990 even though they were actually scored on the same interview schedule. The first group is a younger group including five and six year olds in 1989 and the second group is an older group including six and seven year olds in 1990. The means indicate that the older children started out scoring 4.6 points higher than the younger children. Both groups gained approximately the same number of points in the course of the first year, 3.6 (older) and 3.4 (younger) and slightly fewer points in the second year (1.9 points).

Time	March 89	Nov 89	April 90	Dec 90
1	**14.1 (7.2)**	-	18.7 (6.4)	-
2	-	**17.5 (6.4)**	-	22.3 (4.4)
3	-	-	**20.1 (4.2)**	
4	-	-	-	**22.0 (3.5)**

Table 2: Means and standard deviations of total scores for the entire group on four interviewing occasions.

The group mean change from Time 1 to Time 2 and from Time 3 to Time 4 was statistically significant, representing an improvement of several standard errors of the mean. Its educational significance is less clear-cut. Roughly speaking, the groups' mathematical performance has increased a little more than half a standard deviation over a school year. The small size of this increase might be accounted for in several ways. In the first place, several of the questions asked are not dealt with directly in the usual mathematics curriculum of children of these ages, and so might not be expected to change much over the course of the year. Secondly, the change is artificially depressed by the fact that there is a slight 'ceiling effect', since some children correctly answered most of the questions at the beginning of the year, and thus the interview was not able to detect any substantial improvements in ther performance by the end of the year. Of most significance, however, is the interpretation that growth of mathematical performance in these early years of schooling is a naturally slow process, so that many children by the end of the year will not have reached the levels attained by other children at the beginning of the year.

School Groups

To further study and understand the growth of mathematical performance in young Aboriginal children, it is helpful to divide the data by the three school groupings. Over the three groups, gains in mean scores over the course of the two years are rather similar, so that existing differences between schools at the beginning of the year are still evident at the end of the year. In broad terms, the White middle class schools have the highest performance, followed by the Other working class schools and the Strelley Group respectively. Again the figures* in bold indicate the sequential interviewing on four different occasions.

* Table 3 : Page 28.

Group	Time	Total Scores
White Middle	1 (March 89)	19.7 (4.8)
	2 (November 89)	22.8 (4.2)
	3 (April 90)	22.7 (2.5)
	4 (December 90)	24.1(1.4)
	1 (April 90)	22.2 (3.3)
	2 (December 90)	24.7 (1.5)
Other Work Class	1 (March 89)	13.5 (6.4)
	2 (November 89)	16.6 (5.7)
	3 (April 90)	20.4 (2.8)
	4 (December 90)	22.9 (1.4)
	1 (April 90)	16.8 (6.3)
	2 (December 90)	21.1 (4.1)
Strelley	1 (March 89)	8.7 (6.6)
	2 (November 89)	13.0 (5.6)
	3 (April 90)	14.7 (4.4)
	4 (December 90)	16.1 (2.7)
	1 (April 90)	8.2 (4.9)
	2 (December 90)	12.3 (2.1)

Table 3: Means and standard deviations of total scores for the three school groups on four interviewing occasions.

The line graphs in Figure 1 and Figure 2 illustrate the differences between the three school groups over the four interviewing occasions and two interviewing occasions respectively in a more pictorial way. They show how the differences between the three groups of schools were very similar at Times 1 and 2 but not as similar at Times 3 and 4. The dip in the Middle Class group brought their mean score closer to the Other Working Class group and the increases in the Other Working Class group at Time 4 brought their mean score closer to the Middle Class group.

An analysis of variance was carried out using the difference scores (over the first two interviewing occasions) as the independent variable, and with the school groups as the factor, to determine whether there were significant differences in the changes observed in the school groups over the course of the year. The results indicated that there were no significant differences between the groups. This result is consistent with the informal observations above that there is a considerable consistency in the patterns of change in total scores over the two years, although there are substantial differences between schools in terms of the overall levels of mathematical performance of their children.

Since there was some variability of ages within the three school groups, it was thought prudent to investigate whether there were significant differences in terms of the changes observed over a school year, after the effects of age were taken into account. Accordingly, an analysis of covariance of these data was also conducted, with age in years and months as the covariate. The results showed that the lack of difference between school groups persisted, even after the effects of age are taken into account.

Out of all the subscales, the operations area showed the greatest differences between the groups with the Strelley schools considerably lower in this area than the other two groups. They achieved a mean of 1.4 items correct at the end of the two years compared with 3.1 for the Other Working Class group and 3.8 for the White Middle Class group (out of a total of 4 items). There were two addition items and two subtraction items. The subtraction items proved to be very difficult, especially for the Strelley children, possibly for linguistic as well as mathematical reasons. Since the related subtraction concepts were not taught formally at the Strelley schools, it seems that little growth occurs in this area after formal schooling.

Figure 1. Mean Total Scores on four interviewing occasions.

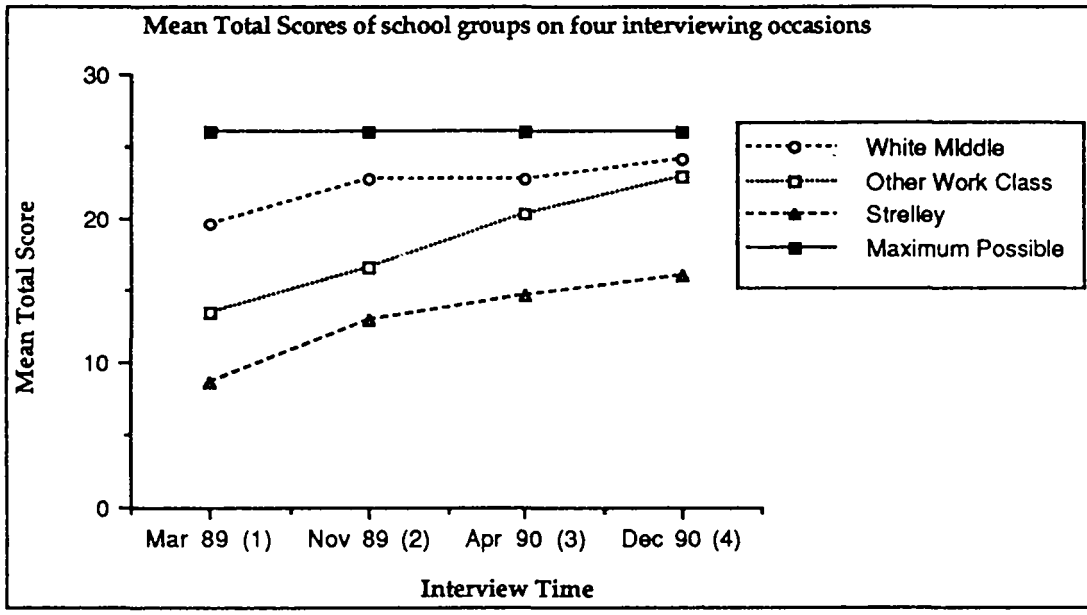
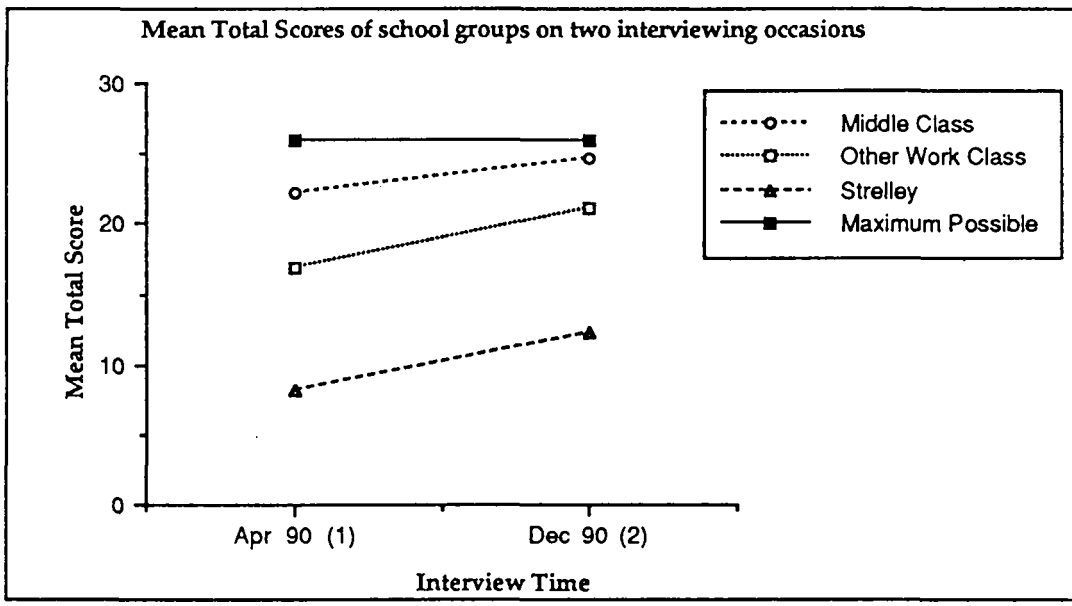


Figure 2. Mean Total Scores on two interviewing occasions.



There were very little differences between the school groups on the quantitative items which involved counting between 6 and 15 blocks. The reading questions asked children to read the numbers: 3, 17, 58, 100 and 106. Generally, larger numbers were more difficult to read, the exception being 100, which is clearly a special case. By the end of the two years, growth was observed for each group, although some students clearly had not mastered recognition of large numbers. Again the Strelley group started out considerably behind in both 1989 and 1990 and remained that way in both years. At the end of 1990 (four occasions) there was about a one point difference between each of the groups.

The pattern items (putting correct shapes in a pattern) showed less uniform growth than those of the other areas. There seemed to be linguistic and cultural explanations for this since many children clearly found it difficult to describe a pattern whereas others found it much easier. The differences between the groups were quite substantial with the White middle class group achieving scores close to the maximum from Time 1 and the other group achieving closer to the maximum by Time 4. The Strelley group was four points below the maximum at the start of interviewing and had improved by a little over one point but were considerably below the other two groups by the end of the two years. There is little work with patterns in a sequence in either the Montessori or Mortensen programs and it is unlikely that these children would have been introduced to this type of exercise in their out of school environments.

The items on identifying the four shapes (circle, triangle, square and rectangle) indicated whether children had access to the conventional names for geometric shapes. Each of these showed uniform growth, with the word 'rectangle' much more difficult than the other three. It is also significant that the Strelley children did not know these words when interviewed at Time 1 but did at Time 4, presumably because they are included in the Montessori program. The White Middle Class and Other Working Class children were more likely to know the words at the first interview and hence were only able to improve slightly over the period of two years.

Children were very successful at identifying which of two pencils was longer, but many did not realize that weight can only be determined by lifting, rather than by looking. When asked which of two boxes is heavier, the Strelley

children were more likely to guess rather than to lift the boxes to find the correct answer. The last question asked children to find a five cent coin among a set of coins and almost all children were able to do that, although there were still a few of the Strelley children who were uncertain about which was the five cent coin indicating less familiarity with coins in their environment.

Children were also asked to count as high as they could and many children required careful prompting and encouragement to do so. Not all numbers were counted; children were asked to stop at 41 and skip to 68, then stop at 73 and skip to 98, stop at 101 and skip to 197-203 and then finally skip to 997 and count to 1003. There was clear improvement at each school over the year as far as counting was concerned, reflecting the attention paid to this aspect in the early stages of schooling. The differences between the school groups were still noticeable with the Middle class schools consistently being able to obtain a median of 101 the second interviewing time with some children reaching 1003, the other schools only reacing a median of 101 by the fourth interviewing time and the Strelley school progressing up to the median of 41 which was two levels before reaching 101.

LIMITATIONS OF THE STUDY

There are several limitations of this study. In reflection on the interviewing situation, it was evident that some children were frightened by the formal setting. Even though the interviewers tried to make children feel comfortable by speaking quietly and in a slow pace, there were still children who felt ill at ease and this was quite noticeable. It appeared to be more the case with the very youngest children and more often with Aboriginal children than with non-Aboriginal children. We decided to alter the interview setting in 1990 to see if a more informal setting would alter the children's performance. We also interviewed only children who were 6 or more years old. In 1989 we interviewed some children who were just 4 or between 4 and 6 years old and these children were the ones who were more likely to be frightened by the interview. To make the setting more informal, we have drawn on the work of Kearins (1981) where she describes the kind of testing situation she used:

> School rooms were not used for testing, for instance: the work was done entirely out of doors, under trees, or in partially enclosed playground sheds or verandahs when shelter was necessary, but always in places open to public view and to natural sights and sounds. Materials were set out at sitting rather than table height, allowing a top view and experimenter and subject sat side by side rather than opposite each other. No time limits were suggested for actual performance and all testing was avoided during school breaks. Causal, quiet behaviour (old clothes, soft voice, limited speech, unhurried movements) and 'appropriate' demeanour for an outsider were maintained throughout. These measures were adopted to accord with both adult expectations of children and general notions of courtesy among desert people, and thus to provide maximum psychological and physical comfort for participants (1981, p439).

In the Strelley communities, even though the interview schedule was translated into Nyangumarta and given by Nyangumarta teachers, there was still some concern about the nature of the Nyangumarta language used in some of the items. To determine if the language used affected the performance of children, in 1990 two different interviewers were used. One was the same as in 1989 who used a more 'formal' Nyangumarta text. The other was the teacher of the children who used a more'informal' Nyangumarta in her interviewing. We were unable to notice differences in the results between these two teachers; however, this exercise was confounded by using children who were older and had already been interviewed once so that the interviewing sitution was already more familiar.

As can be seen in the problems we have identified in the actual interviewing situation, the researchers and the community are jointly learning about the best way to evaluate the introduction of a new mathematics curriculum. We are also learning about ways of improving the curriculum and making it have more meaning for the children in the community. In 1990 several workshops were given which reflected on the questions of the use of mathematics in the community and how the mathematics program can be better related to these uses.

In addition we are planning a workshop that will focus on language and mathematics in the Strelley communities. We see thse kinds of dialogues with the community as essential ingredients in improving the learning of mathematics for the children of Strelley.

In 1991 we have also decided to use a more suitable comparison group of Aboriginal children. They are children who are currently taught in a state school located in a desert community similar to the Strelley community. They will have more similar child-rearing practices and have little contact with urban life. This longitudinal study will continue for at least another two years so that comparisons with other programs can be made and improvements in the Strelley curriculum can be continued. The extent to which the materials and curricula impact upon these differences could not be determined with the study at this early stage.

CONCLUDING COMMENTS

There are three main conclusions from this study. Firstly, as far as the interview questions used are concerned, there are enormous ranges of mathematical performance within individual schools and across the schools. We were not surprised by these observations.

Secondly, the change in mathematical performance over the course of most of a school year is rather small, reflecting the remark in the Cockcroft Report (1982) that mathematics is both difficult to learn and to teach. It is well to be realistic in terms of our expectations over the early years of mathematics.

Thirdly, the comparisons between schools suggest that the Aboriginal children in the remote community do not fall further behind their counterparts in either the middle class or working class schools, but nor do they catch up any of the substantial gap between these groups. Even though we have used rather 'precise' statistics to measure the differences between these groups, we are also aware that these children inhabit significantly different learning environments. These factors have to be taken into consideration when judging the impact of a new mathematics program in a remote Aboriginal community.

NOTE 1

This report is the result of a joint project between the Strelley Community and its Aboriginal Independent Schools and the School of Education at Murdoch University. A team of researchers at Murdoch University (including Jan Currie, Barry Kissane, Marian Kemp, Beth Powell, Ann Chapman and Harriett Pears) has been involved in this research and program development since 1984. Many teachers and individuals have been involved in the project from the Strelley Communities as translators (Monty Hale, Fred Bradman, Gwen Bucknall), as interviewers (Fred Bradman, Lolla Walker and Gwen Bucknall) and as teachers (Angelena Handley, Selina Mick and Mary Ellen Hawks). The Principals and the Community have provided hospitality and communicated their genuine interest in the project. Ray Butler of the Nomads Charitable and Educational Foundation has given advice and guided the project through its many stages.

NOTE 2

We would like to acknowledge the funding received for this project from the Sidney Myer Foundation in 1988, the Department of Employment, Education and Training in 1989, Murdoch University in 1989 and 1990 and the Australian Research Council Small Grants Scheme in 1991.

REFERENCES

Brod, R.L. (1979) *Choctaw Education.* LPS & Associates, Rocky Boy's Route, Box Elder, MT 59521, December.

Bucknall, J. and Bucknall, G. (1988) *Review of Aboriginal Independent Schools, Western Australia,* Prepared for the Review of Aboriginal Independent Schools' Steering Committee, Broome: Ngurnipali Ngurnarri: Aboriginal Education Consultants.

Butler, S.R. and Marsh, H.W. (1986) "Reading and Arithmetic Achievement in Primary Years for Students from Non-English Speaking Families: A Seven-Year Longitudinal Comparison", *Australian Journal of Education, 30 (1), 23-44.*

Cockcroft, W.H. (1982) *Mathematics Counts,* London: HMSO.

Cocking, R.R. and Chipman S. (1988) "Conceptual Issues related to Mathematics Achievement of Language Minority Children", In Cocking R.R. and Mestre J.P. (Eds) *Linguistic and Cultural Influences on Learning Mathematics.* Hillsdale, New Jersey: Lawrence Erlbaum Associates.

Coombs, L.M. (1970) *The Educational Disadvantage of the American Indian Student.* Las Cruces, New Mexico: New Mexico State University.

Cheek, H.N. (1984) "A Suggested Research Map for Native American Mathematics Education", *Journal of American Indian Education,* 23 (2) January, 1-9.

Cuevas, G. (1984) "Mathematics Learning in English as a Second Language", *Journal for Research in Mathematics Education,* 15 (2), 134-144.

Currie, J., Kissane, B., Kemp, M., & Pears, H. (1990) "Improving Mathematics of Aboriginal Children in a Remote Community: Interview Results 1989". Unpublished paper, Murdoch University.

Dawe, L. (1983) "The Development of Inquiry Skills in Mathematics and Science: Problems for the Bilingual Child", in D. Blane (Ed) *The Essentials of Mathematics Education. Melbourne: Mathematics Association of Victoria.*

De Lacey, P.R. (1970) "A Cross-Cultural Study of Classificatory Ability in Australia", *Journal of Cross-Cultural Psychology,* 1 (4), 293-304.

De Lacey, P.R. (1971) "Verbal Intelligence, Operational Thinking and Environment in Part-Aboriginal Children", *Australian Journal of Psychology,*23 (2), 145-49.

De Lemos, M. (1969) "The Development of Conservation in Aboriginal Children", *International Journal of Psychology,* 4 (4), 255-69.

Graham, B. (1984) "Finding Meaning in Maths: An Introductory Program for Aboriginal Children", *The Aboriginal Child at School,* 12 (4), 24-39.

Graham, B. (1988) "Mathematical Education and Aboriginal Children:, *Educational Studies in Mathematics,* 19, 119-135.

Hedges, L.V. and Stodolsky, S.S. (1987) *A Formative Evaluation of Kindergarten Everyday Mathematics,* Chicago: University of Chicago School Mathematics Project.

Hedges, L.V., Stodolsky, S.S. and Mathison, S. (1988) *A Follow-up of Kindergarten Everyday Mathematics Users.* Chicago: University of Chicago School Mathematics Project.

Hunting, R. & Whitely, H. (1983) "Mathematics, Prior Knowledge and the Australian Aborigine", *Research in Mathematics Education in Australia, MERGA,* 3-24.

Kearins, J. (1976) "Skills of Desert Aboriginal Children", In G.E. Kearney and D.W. McElwain (Eds.), *Aboriginal Cognition in Tertiary Education: A Framework for the 1985-87 Triennium.* Woden, ACT: AGPS.

Leap, W.L. (1988) "Assumptions and Strategies Guiding Mathematics Problem Solving by Ute Indian Students", In Cocking R.R. and Mestre J.P. (Eds.) *Linguistic and Cultural Influences on Learning Mathematics.* Hillsdale, New Jersey: Lawrence Erlbaum Associates.

Myers, D.E. and Milne, A.M. (1988) "Effects of Home Language and Primary Language on Mathematics Achievement: A Model and Results of Secondary Analysis", In Cocking, R.R. and Mestre, J.P. (Eds.) *Linguistic and Cultural Influences on Learning Mathematics.* Hillsdale, New Jersey: Lawrence Erlbaum Associates.

Schindler, D.E. and Davison, D.M. (1985) "Language, Culture and the Mathematics Concepts of American Indian Learners", *Journal of American Indian Education,* 24 (3), 27-34.

Scott, P.B. (1983) "Mathematics Achievement Test Scores of American Indian and Anglo Students: A Comparison", *Journal of American Indian Education,* 22, 3 (May),

Seagrim, G. and Lendon, R. (1980) *Furnishing the Mind: A Comparative Study of Cognitive Development in Central Australian Aborigines.* New York: Academic Press.

Stigler, J.W. and Stevenson, H.W. (1987) "Mathematics Classrooms in Japan, Taiwan, and the United STates", *Child Development,* 58, 1272-1285.

United States Senate, Special Subcommittee on Indian Education. *Indian Education: A National Tragedy - a National Challenge.* Washington, D.C.: U.S. Government Printing Office, 1969.

Watson, H. (1987) "Learning to Apply Numbers to Nature", *Educational Studies in Mathematics,* 18, 339-357.

Wright, B.D. and Stone, M.H. (1979) *Best Test Design.* Chicago: MESA Press.