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MATHEMATICS PROGRAMS FOR INDIGENOUS STUDENTS: SOME GUIDELINES

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This paper provides an overview for teachers who wish to develop a more appropriate mathematics program for their Aboriginal or Torres Strait Islander students. It covers cultural, linguistic and environmental issues, as well as purely mathematical and methodological procedures. Current literature and reports from teachers indicate that many indigenous students are not performing well in mathematics. It is hoped that the suggestions contained in this article will lead to a more rewarding experience for both teacher and student.

It is generally agreed by teachers of Aboriginal and Islander students that most students are not performing at a satisfactory level. This conclusion has been documented by Bourke and Parkin[1], by the Curriculum and Research Branches of the Departments of Education in the Northern Territory[2] and Western Australia[3], and by others, including Bishop[4], who wrote -

> Experience has shown that many Aboriginal children do not manifest many [mathematical] outcomes at a level comparable with that obtained by European children.

The causes of this relatively unsatisfactory performance are complex, but may usually be traced to a combination of environmental, cultural and linguistic differences, as well as to unsuitable teaching programs and methods.

There is a noticeable lack of literature on the subject available to teachers, and it is hoped that the following comments will be

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useful in drawing up a mathematics program whose content and methodology will be more relevant and meaningful to the students.

DEVELOPMENT OF MATHEMATICAL CONCEPTS

Cultural and Environmental Influences

Indigenous students from isolated communities are less familiar with numbers, measurement and other mathematical and scientific concepts than their counterparts of the mainstream Western society. de Lacey[5] writes that performance in tests tends to vary directly with the extent of contact experienced with Europeans and their technology. This may be because high contact Aboriginal children learn to perform the specific tasks of the tests or that Aboriginal children in close contact with Europeans might enjoy a richer variety of experience than remote Aboriginal children. de Lacey continues -

> This effect is not confined to Aborigines. European children encountering a greater than average variety of life experiences are also likely to show faster cognitive growth than disadvantaged European children.

This is not to say that traditional cultures have no mathematical content. They do have their own counting systems and methods by which mathematical-type decisions are made, based on their own values and perspectives on life. These values and approaches to problem solving unfortunately are not always appropriate in the modern setting in which Aborigines and Islanders find themselves, and may put them at some disadvantage with other groups. Beck[6], notes that -

> These traditional values and approaches persist in a community and students are affected by them even though they may no longer be able to articulate their importance.

This is the case with many urban Aboriginal and Islander children.

Build on Strengths

It is important that teachers, especially in the primary and lower secondary school, learn something of the way in which their students conceptualize mathematically, and their customary methods of solving problems. Teachers could compare and contrast traditional Aboriginal and contemporary methods of measuring length, distance, weight, area and time etc. Useful references on this are Harris[7], and Jones[8].

Teachers might also identify some of the unique strengths of their students and capitalise on these; for example, the highly developed visual and photographic memory of many indigenous students, general spatial ability in terms of direction finding, artistic and musical ability, appreciation of relationships between small numbers and the mental arithmetic skills displayed in card games. Some of these abilities are discussed in Harris.

Conventions and Experiential Background

Beck[9] writes -

> Everything that the student will be learning in school he/she will be assimilating from within a context of his/her prior learning, which may be as vague though influential, as the natural environment which surrounds his/her community. All aspects of the student's culture must be observed, studied, participated in and assimilated to a degree by those responsible for teaching the students and by those creating instructional materials.

Conversely, teachers operate with a set of conventions based on their own experience, and often they are not aware of them or how they were learned. With particular reference to geometry, Bishop,[10] who has done research in Papua New Guinea, writes -

> The representation of a three-dimensional object by means of a two-dimensional diagram demands considerable conventionalising which is by no means immediately recognisable by those from non-Western cultures.

Teachers need to explain and demonstrate the use of a dotted line, the conventions associated with projections and perspective drawing, that parallel lines remain parallel etc. No doubt the European teacher is as much at a loss to understand the symbolism and conventions employed by an Aboriginal artist in his bark paintings. McGarvie, an advisory teacher with the Queensland Department of Education, is currently trialling a graphics course which makes use of colour and designs on the faces of objects to help students visualise how to represent a solid object from different angles.

Need for a Scientific Approach

Gay and Cole,[11] in a study of traditional means of learning among the Kpelle people in Africa, concluded that some school subjects are most effectively taught by methods other than those found

in the traditional culture, and Stephen Harris,[12] writes -

> The methods of teaching maths must involve scientific or analytical method, rather than a method which appeals to the opinions of traditional authority figures (or the dreaming) or which uses rote memory and imitation.

Furthermore, though the content of some basic maths should be related to or contrasted with traditional concepts, much of the content of secondary school maths cannot be related to traditional knowledge at all.

The Nature of Mathematics

Mathematics deals with the quantitative properties of objects and relationships rather than the qualitative ones. Answers can, at times, be found by intuition and hunches. However, feelings and subjectivity cannot be relied upon in a subject which demands objectivity, rigour and proof. Many students in primary and secondary school seem to depend on wild guessing and to have no knowledge or understanding of the processes involved in mathematical reasoning: the answers they give are completely unreasoned. Ultimately, the student should be able to use deductive and inductive reasoning, critical thinking, scientific method and have developed problem solving techniques.

LANGUAGE AND MATHEMATICS

Second Language or Dialect

To begin with, English is either a second language or dialect for most Aboriginal and Islander students, even for those living in the urban areas. This puts the students at a great disadvantage in all school subjects. Smith[13] showed, in Queensland, that there is an inverse relationship between the amount of English verbal content in mental tests and Aboriginal children's scores on them.

Bishop[14] found that in Papua New Guinea, many of the "home languages do not provide an adequate base for describing spatial environment scientifically", and this probably applies in Australia also. Consequently, the student has the problem of trying to understand concepts and terms with which he is unfamiliar in a language which he doesn't fully understand.

Teachers must exercise care in the use of standard English structures, particularly question forms, tenses, prepositions,

articles, word order, the third person and passive voice (the last two of which frequently occur in mathematical and scientific works). Idiomatic expressions should be avoided. The active voice and the type of language used in definitions and in scientific statements should be given special attention. Teachers wishing to know more about language and its use should consult the English teachers on their staff. A useful reference on the topic is Murray[15].

Mathematical Jargon

Much of the mathematical jargon with which we are familiar as mathematicians is completely foreign to indigenous students. The special words, phrases and symbols that are used in mathematics should be identified and their meanings taught. Any unnecessary jargon should be avoided. To this end it is worth going through programs, textbooks and tests and making a maths spelling list and dictionary for students. As each word represents a specific concept, such a list should also help students to express themselves more clearly. It is also worth giving students practice in using equivalent, verbal, written and mathematical expressions.

Situational Method

The situational approach used in teaching English as a second language could be used to reinforce or illustrate the meaning of a wordy mathematical problem. For example, a classroom shop may be used as the basis for some problems on money, as well as to teach the meaning, in real life, of a written money problem.

Bilingual Approach

Students who have first learned the basics of mathematics in their own language or dialect, will probably have a clearer understanding of the subject than those who have been taught in a second language or dialect. Educationalists are already recommending that children learn to read in the vernacular before learning to read in English. In most instances, however, this is not practicable.

Mix with the People

It is appreciated that most mathematics teachers will not be at ease with linguistics. However, they will soon develop an understanding of the linguistic barriers to learning, and will probably

develop an intuitive idea of how best to communicate with students, if they get out and mix with students and people in the community.

CHILD CENTRED PROGRAMS AND DIAGNOSTIC TESTS

Relevance

Programs should be tailor-made to suit the specific levels of achievement and needs of the students rather than borrowed from other schools which have quite different student populations. Some of the standard syllabi laid down by the various Departments of Education, which may be suitable for middle-class urban students, may not be appropriate for Aboriginal and Islander children. Their unsuitability may be in terms of content, method or expected levels of achievement.

Selecting and Interpreting Tests

In order for the teacher to assess the level of attainment of his students in mathematics, he may find it necessary to construct his own diagnostic tests or to administer commercially produced tests. Many conventional tests are culturally or linguistically biased, assuming a middle-class Western background and familiarity with standard English. Criterion-referenced tests such as "Yardsticks" available from Australian Council for Educational Research, are useful for diagnosing student weaknesses in a range of topics. The "Catim" tests, also available from A.C.E.R., provide a class profile, and the Schonell Diagnostic Arithmetic Tests, which are easy to administer and correct, provide information on the child's level of achievement in the four operations. Further information on suitable tests may be obtained from the Australian Council for Educational Research.*

Diagnostic tests are designed to locate where and why children are experiencing difficulty. However, most of the tests stress computational proficiency rather than mathematical understanding, which is not so easily tested. Diagnosis in this area should be accompanied by the teacher's careful observations of the child's oral and written work and by pupil/teacher discussion.

Clark *et al.*[16] write that our institutions tend to debase the black child's concept of himself and the group with whom he

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identifies, and it is the child's consequent lack of self-esteem that contributes significantly to his low vocational aspirations and academic achievement. This is borne out by the apparent lack of motivation of Aboriginal and Islander students in most schools, though there are notable exceptions. My own observation has been that where the principal and staff emphasise the personal worth of each child and group of children, self-esteem is maintained, the students are much happier in the school, and they achieve more. Unfortunately, this is not always the case. In one school where Aboriginal students averaged fifty days absence per year, the mathematics master said that he did not mind the students being absent from his class as this allowed him to get on with the job!

Rationale

In maths, students often ask, "What are we doing this for?" It is a good question and sometimes hard to answer, but teachers should be able to give a reasonable answer. If not, then perhaps there is no point in doing that particular piece of work. Topics should be both relevant and meaningful to the student.

Need to Know

If students can see an immediate and real need for knowing something, then it is more likely that they will respond positively. It is important to be aware of what matters to our students and to relate, if possible, the students' interests to their studies. Ambitious students who realise that maths is a prerequisite for many occupations may be motivated by this also.

Variety

Try a variety of approaches and teaching methods: traditional, demonstration, discovery learning, project work, team teaching, programmed and self-paced instruction, and ascertain which methods are the most successful with your class.

Maths for Maths Sake

The teacher's own enthusiasm for his subject is likely to motivate his students. Maths can be enjoyed for its own sake, for its logic, power, precision, beauty, simplicity, symmetry, economy and applicability. Learners in every culture are influenced by

their teachers' attitudes and behaviour and this may be more so with indigenous students, because of traditional modes of cultural transmission.

Maths Resource Centre

Some schools have established a Mathematics Laboratory or Resource Centre for use by staff and students, run on much the same lines as a library. Such centres contain: models, books, journals, games, puzzles and charts, and may be used by students during breaks. The National Council of Teachers of Mathematics (U.S.A.) has a brochure called "Mathematics Laboratory Bibliography" which should be useful.

Student Success

It is essential for a student to experience success in the subject, especially when the student's expectations are not very high. If he does experience success, he will enjoy his work all the more and take greater interest. If he fails continually, he will lose interest and may become rebellious. The teacher needs to to gauge accurately the level of work he sets, and grade questions carefully, so as to ensure a measure of success for even the slowest children.

Pupil/Teacher Relationship

The attitude of Aboriginal and Islander students is determined as much, if not more, by the relationship of the students to the teacher, as it is by the child's inherent interest in the subject. Julia Koppe, of the Townsville College of Advanced Education, refers to the "person rather than task orientation", of the Aboriginal child, and emphasises the need for teachers to play a supportive and encouraging role in the education process. The teacher's expectations of his students have a marked influence on the students' own expectations and consequent performance. Assignments should always be marked with positive and constructive comments. Sarcastic and destructive remarks are counter-productive and should be avoided.

The Extended Family

In traditional Aboriginal society the extended family and kinship system exert considerable influence over the behaviour of members. Teachers who ignore the traditional structure of the

society are likely to lose the respect of students and to meet with unco-operative behaviour. In some communities the people will extend their family to include the teacher; this is an honour, a sign of acceptance, and if the teacher is able to reciprocate, it will enhance his relationship with the community and students. It allows the teacher to participate more fully in community life. However, it is probably better not to become involved in this way if the teacher is unwilling to reciprocate or to accept the obligations along with the privileges.

TEACHING AIDS

Teaching aids in themselves are often of little use unless integrated into a teaching program. Many schools are stocked with aids that are collecting dust, whilst in others they are used in an ad hoc manner and their use bears little relevance to the overall teaching strategy. The types of materials which are available include: measuring kits, clocks and watches, calculators, meccano and other construction kits, dice and card games, wall charts, tapes and films. A useful reference is *Games and Puzzles for Elementary and Middle School Maths*, published by the National Council of Teachers of Mathematics.

MATHS AND THE ENVIRONMENT

An exploration of the student's environment will reveal maths in nature, buildings, games and hobbies, as well as in traditional culture. Encourage students to describe their world in mathematical terms, using precise numbers and measures, comparisons, estimations, calculations and predictions.

Surveys involving making observations, sampling, collecting and organizing data and drawing conclusions, are often popular with students, especially if they can work in pairs or small groups. Most students are enthusiastic about their own personal statistics: birthday, age, weight, height, etc., in comparing these with members of the class, and in making charts. Themes involving engineering, science and commerce, for example, motors, electricity, the weather and geology, navigation and map reading, fund raising and accounts, may stimulate students and help to make good a lack of such experiences in the local community.

PRIORITIES IN THE MATHS PROGRAM

The set of priorities outlined below for a junior secondary program, is based on the degree of relevance of the material to

the student, rather than on its mathematical difficulty. There is, however, a correlation between the difficulty of the topic, the readiness of the student for the topic, and its relevance. Those topics which are most essential are also the more basic, and are those for which the student is ready at an early stage.

Everyday Life Requirements

First priority is given to the mathematics judged to be essential for everyday life. A short list of such basic maths includes: concepts of number, counting and place value, measurement and units of measurement, time and the calendar, money, estimation, the four operations and the basic number facts, decimals, percentages, simple fractions, and unit cost problems. A brief examination of these will show that, whether the student lives in a traditionally oriented, rural, or urban community, he/she will need some knowledge of the above in order to cope successfully with commonplace shopping, pay, transport, communication, and postal situations.

In addition to the foregoing, students who become a little more involved in Western society will be expected to know something about calculations involved in consumer affairs, maintenance of house and car, budgeting, taxation, banking, social services, the metric system, surveys and statistics, travel, club accounts and the economy.

Maths Required by the Year 10* School Leavers

When students reach Year 10, most of them are planning to enter the work force; the teacher should ensure that his particular class is prepared for the type of work they are likely to obtain, whether it be labouring, semi-skilled, commercial, public service, technical or professional. On entering most trades or professions, students are expected to have some knowledge of operations with fractions, more difficult applications of decimals, percentages and fractions, ratio and proportion, geometry and trigonometry, and to be able to use a calculator.

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* Queensland terminology - equivalent Form 3 other states.

Pure Maths and Interest Topics

Finally, those students who aim to proceed with maths into Year 11, and who have mastered the basic maths and the real world applications outlined above, may proceed with a more academic and rigorous maths program. Whichever category your students fall into, interest topics and projects which may not have a direct bearing on their program are recommended, if time permits, and if they make the program much more enjoyable for all concerned.

Trimming the Program

Teachers of indigenous students usually find that there is insufficient time to cover their syllabus adequately, and it becomes necessary to delete some topics. Some would suggest leaving out imperial measures, Roman numerals, history of maths, the formal treatment of the number laws, some of the work on sets, and much of the jargon of "New Maths".

The Decimals/Fractions Debate.

It is also felt that with increasing metrification and the use of calculators at all levels of the trades and professions, decimals should be given precedence over fractions. Time spent on the teaching of decimals is more productive than time spent on fractions, and once decimals have been mastered, percentages follow on quite simply. The January and March 1979 editions of the *Arithmetic Teacher*[17] discuss this issue.

Suggested Program for Cape and Gulf Schools

A group of teachers from the Cape and Gulf schools in Queensland, with myself as co-ordinator, compiled a draft set of programs[18] for Years 8, 9 and 10, based on these priorities. They are being trialled this year and will be revised next year*.

ORGANIZATION AND METHODOLOGY

There is a tendency, when adapting programs to suit local cultural and environmental conditions, to do away with many necessary

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*Teachers interested in these should write to:- Inspector of Indigenous Education (Secondary), Queensland Dept. of Education, P.O.Box 33, North Quay, Brisbane, 4000.

methodological procedures on the pretext that they are not part of traditional Aboriginal or Islander culture. Stephen Harris[19] argues that -

> We cannot hope to develop traditional Aboriginal schools because schools are not traditional Aboriginal institutions.

Although every attempt should be made to incorporate current expressions of Aboriginality, it is still necessary to retain some of the procedures of 'traditional Western' systems. These include regular attendance, course and lesson planning, revision and assessment, record keeping, and regular marking of students' workbooks. In mathematics it is still advisable to begin lessons with a few short mental questions, to require neatness, to carry out frequent revision, and to set homework or assignments.

TEXT AND SOURCE BOOKS

Unfortunately, there are very few texts written specifically for these students, and teachers will probably find it necessary to supplement any text used with their own sets of notes and questions. The criteria which I think are necessary for a good secondary textbook for students who are not performing well in maths, are that the book, or series of books, should revise basic maths taught in primary school; topics should be developed from the concrete and be related to the child's environment; it should be clearly and attractively laid out; although the maths may be basic, it should be presented in a manner appealing to adolescents; it should contain no unnecessary jargon or inconsequential material; there should be ample well-graded examples and questions; it should contain practical applications; and the reading level of the text should be compatible with the child's reading age.

INVOLVING TEACHER AIDES

If an Aboriginal or Islander teacher aide is employed in the school, the opportunity exists for the teacher to utilize his/her local knowledge, experience,and special relationship with the students in a number of ways. Firstly, any knowledge the aide has of the concepts of number and measurement used in the community, would be useful. The aide can assist in the organization of surveys and excursions, and he/she will probably be effective in small group work and on a one-to-one basis with students. The aide's knowledge of both standard English and local dialects should improve communication between the teacher, students, and community. A teacher aide

who is familiar with the school programs and routine, also adds stability and continuity to the school.

CONTINUITY

One of the major problems of Aboriginal and Islander Schools is the regular turnover of staff and the preponderance of innovative and experimental programs, many of which are never carried through or properly assessed. There is also the problem of new staff appointees who are ill-prepared and have no experience in the teaching/learning of indigenous students, and who usually require several months to begin to communicate effectively and to appreciate the issues. The result of all this is that the student's educational career proceeds at an erratic and inefficient rate.

For these reasons, it has been decided in some schools that more prescriptive school and subject area programs, which take into account local conditions and provide steady progression through the grades, should be prepared. This is particularly important in maths, where topics develop sequentially. The maths staff needs to meet regularly and arrive at a consensus on the content of the program. A running commentary on the program should be kept and revisions made annually.

Frank Young[20] states:

> There is a real need for a total school program. In schools with pre-school, primary and secondary sections, this will be a continuous curriculum. There should be no discontinuities in the overall philosophy and policy of the school and in the development of subject areas. This entails objectives in each being set out from pre-school to Year Ten and an effective recording system which can be passed on to the next teacher to show as clearly as possible what the situation is for the children.

CONCLUSION

The relatively poor level of performance of Aboriginal and Islander students in mathematics, points up the need for a closer look at the suitability of current programs, and teaching and learning strategies. It is hoped that some of the foregoing suggestions will be useful to teachers and lead to the improved performance of students. In particular I would emphasise that, to develop the optimum program, teachers should become involved with the local community, and integrate local knowledge and values with their own.

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