BICULTURAL PERSPECTIVES IN YEAR NINE SCHEMES

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This paper summarises some key findings from a Masters thesis in which the bicultural perspectives in year 9 mathematics schemes were explored. Schemes from fifteen North Island provincial city, state secondary schools were collected and analysed. This paper canvasses relevant research and Ministry of Education expectations, and compares with these the evidence of bicultural perspectives found in the schemes. The study schemes were collected in 1999 as part of a larger study into scheme preparation and content.

Schemes ideally provide a template for the teacher to follow throughout an academic year, giving guidance on topics, level of presentation and examples of suitable tasks for learning and assessment. Schemes are likely to strongly and directly affect classroom learning and are therefore an important area to explore in order to ascertain the levels of guidance and assistance they are able to give to individual teachers in terms of curriculum delivery. Curriculum aspects missing from schemes may also be missed in classroom programmes.

This paper acknowledges that the inclusion of bicultural perspectives in schemes is only one way towards enhancing the bicultural perspectives of mathematics classroom programmes and conclusions about classroom teaching and learning cannot be directly drawn from the findings of this research. However this paper does suggest that classroom teachers can be assisted in making their classroom programmes biculturally rich through use of schemes which include detailed bicultural perspectives. This paper focuses on findings from *mathematics* schemes but similar questions regarding scheme content are also relevant within other curriculum areas.

The research questions addressed by the study were:

What is the (bicultural) content of year 9 mathematics schemes?

How does this vary from school to school?

Background

Both the National Education Goals (1993) and MINZC (1992) refer to the incorporation of bicultural perspectives within learning programmes. However, neither gives specific requirements nor guidelines as to how schools are to incorporate such perspectives.

The National Education Goals that relate directly to the inclusion of bicultural perspectives are goals 1, 2 and 10. These are:

1. The highest standards of achievement, through programmes which enable all students to realise their full potential as individuals, and to develop the values needed to become full members of New Zealand's society.
2. Equality of educational opportunity for all New Zealanders, by identifying and removing barriers to achievement.
10. Respect for the diverse ethnic and cultural heritage of New Zealand people, with acknowledgement of the unique place of Mäori, and New Zealand's role in the Pacific and as a member of the international community of nations.

(Ministry of Education, 1993, pp 3,4)

In 1999 the Ministry of Education published an amended set of National Administration Guidelines (1999a, p 25) to be effective from 1 July 2000. They refer more specifically and strongly than the earlier guidelines, to addressing the learning needs of Mäori students as illustrated by National Administration Guideline 1, v. The earlier *1993* guidelines were the guidelines that were in place when the study schemes were written and it is to these the paper shall refer.

Pages 12 and 13 of MINZC include statements about the inclusion of bicultural perspectives in mathematics programmes. This section discusses the need to teach mathematics in a way that is relevant to students' lives in order to enable them to connect mathematics to their experiences. It states:

> "It is particularly important that mathematical learning experiences for Mäori students acknowledge the background experiences which have led to the formation of ideas and skills which those students already have. Mäori students will be helped to achieve if teachers acknowledge and value those ideas and experiences
> (MINZC, p 12)."

The emphasis given to catering for the needs of Mäori students by the current curriculum is much greater than was given by the previous syllabus, *Mathematics: Forms 1 to 4* (Department of Education, 1987). This syllabus did not specifically reference Mäori students, but simply included within its aims, that students should be helped to see "the contribution of mathematics to different cultures (p 4)." Incorporation of new aspects to the curriculum is a problematic issue as indicated in Kilpatrick's (1995) discussion of curriculum change which asserts that "the best predictor of today's curriculum in a classroom is what that curriculum has been in the past (p 23)."

Mäori students currently make up sixteen percent of secondary students (Ministry of Education, 1999b, p 23). A range of recent research shows that Mäori students continue to under-perform in mathematics on traditional measures. For example, the recent Third International Mathematics and Science Study found that that the mean mathematics score for year 9 Mäori students was twelve percent below the mean score for year 9 Pakeha/European students (Garden, 1996, p 70). This result is similar to that of the Second International Mathematics and Science Study study result (Binns et al, 1987), which suggests no apparent improvement had been achieved at the year 9 level over the intervening decade.

Other research relating to the achievement of Mäori students in mathematics includes:

- the EIME (Forbes, Blithe, Clark, & Robinson, 1990) study which showed differences at Form 3 in favour of European over Mäori students. Furthermore, the study found that these differences were unchanged from 1981 (p 44), and is consistent with the SIMS result above;
- a research report prepared for the Ministry of Education by Clark (1998), which outlines differences in participation and success rates in mathematics of Mäori students, and also backgrounds New Zealand changes in mathematics education for Mäori over recent years;

- an article (Forbes, Te Puni Kökiri, 1993), that stated that Mäori girls at Form 3 were "'undecided' about the usefulness of mathematics or their future study of it (p 63)." It is likely that this lack of feeling for the purpose of studying mathematics negatively affects performance;
- National Education Monitoring Project results (Flockton & Crooks, 1997), which found that data from year 8 students showed statistically significant differences between Mäori and non-Mäori students on forty one of the fifty three mathematical tasks, and in each case the non-Mäori students performed better than the Mäori students (p 66);
- Barton's (1995) observation that the lesser success by Mäori students in mathematics is a significant problem for Mäori students due to the 'gate-keeping' nature of the subject; and
- Fitzgerald's study of New Zealand graduates (1977), which found that "aspects of the education system taken as routine and unproblematic by Pakehas can be seen as major barriers from another cultural perspective."

Some researchers, such as Ohia, (1993), and Knight, (1994), believe there to be a link between the performance of Mäori students and the lack of bicultural perspectives in mathematics programmes:

> "The language, the examples, the materials and the values of mathematics programmes inescapably reflect the dominant Pakeha tradition. The experiences, language and aspiration of Mäori learners have been ignored (Ohia, 1993, p 38)."
>
> "Poor performances by Mäori learners in mathematics could be attributed to the failure of mathematics educators to make the connections between the students' experiences and the subject matter (Ohia, 1993, p 41)."

Mäori ability in mathematics is well established (see, for example, Knight, (1994) and Bush, (1988)), and Mäori use of mathematics in pre-European times is also well documented ((Metge, (1988), Barton, (1990), and Bush, (1988)). These results indicate that differences in achievement levels between Maori and non-Maori are not due to lack of ability or affinity for the subject area.

Many authors suggest a range of ways to address the issues of lack of engagement and success by Mäori students. Some of these include: the 'Statement of Intent' in: *Pangarau*, (Te Puni Kokiri, 1993, p 10); Ohia, (1991); Barton, (1986); Bishop, (1999); Clark, (1999); Knight, (1994); Kidman, (1995); Begg, (1999); and Bush, (1988). These statements relate to this study only indirectly, as they

focus on aspects of mathematics education other than scheme writing and content. However, inferences regarding the scheme content that may be likely to support bicultural mathematics programmes may be drawn from them. For example, Barton (1986) stated:

> "In moving towards bicutural mathematics classrooms we must consider not just curriculum content, but also teaching methods and the hidden curriculum of classroom behaviour, organisation and evaluation techniques (p 11)."

Teachers could be supported to develop such classrooms by having a scheme that incorporates guidance on appropriate teaching, assessment and organisation methods, and the Mäori students within the classroom may then be more likely to engage in, and have more success in mathematics.

Curriculum Content, Teaching and Learning Methods

The importance of the use of bicultural examples in mathematics programmes has been emphasised by many researchers (Ohia (1993), Silver, Smith and Nelson (1995), Leder (1995), Begg (1999) and others). According to Ohia (1993), "learners 'learn better' if their experiences and their culture and language are integrated into the learning process – because education is successful when it builds on what learners already know (p 37)." International researchers also emphasise this idea. For example, Silver, Smith and Nelson (1995) concluded from their American studies:

> "Unless the mathematics curriculum includes real contexts that reflect the lived realities of people who are members of equity groups and unless these contexts are rich in the sorts of mathematics which can be drawn from them, we are likely to stereotype mathematics as knowledge that belongs to a few privileged groups (p25)."

Leder (1995) states "Mathematics educators … who work within a constructivist paradigm argue that students actively and uniquely construct knowledge within the framework of their own experiences… (p 28)." MINZC acknowledges this (p 12), implying that Mäori students have failed to reach their potential because they were not encouraged to connect new mathematical concepts to previously held knowledge, experiences and skills.

The APEC report on curriculum development and achievement standards (Clark, 1994) lists the methods used by APEC countries to encourage students from minority and indigenous backgrounds to participate in mathematics. Amongst the wide range of methods listed, the report noted that approximately half of the twelve participating countries claim that they provide ethno-mathematical

material in their curricula[1]. This suggests that inclusion of such material is commonly seen as a means for improving the mathematics achievement of indigenous people.

Clark (1998) states that "culturally appropriate and undecontextualised examples are cited by many Mäori authors (Trinick, 1993; Dewes, 1993) as important factors required for Mäori children to succeed in mathematics (Clark, p 8)" and Begg (1999) suggests "Adding a Cultural Dimension to School Mathematics." This involves the use of strategies such as: use of indigenous names in the place of Pakeha names; considering the mathematics in an artefact; and using examples such as tukutuku panels.

Bicultural Perspectives in MINZC and Curriculum Handbooks

It would be reasonable to expect that the mathematics publications of Learning Media and the Ministry of Education would model the use of bicultural contexts, and provide relevant practical ideas for teachers.

MINZC explicitly provides a very small number of bicultural activities in its Sample Assessment Activities and Suggested Learning Experiences. Examples within levels 3 to 5, (the levels of MINZC most relevant to this study), are found in the following strands:

- Measurement level 4 (p72);
- Geometry levels 3, (p103), 4 (pp 105, 106) and 5 (pp 111, 112); and
- Algebra level 5, (p 150).

The Learning Media handbooks are also light in their treatment of mathematics using Mäori contexts. *Developing Mathematics Programmes* (Ministry of Education, 1997) includes no specific statements or suggestions regarding how teachers might write their schemes in order to address the learning needs of Mäori students. Rather it includes non-specific statements such as the need for programmes to include "open-ended problems with realistic contexts that are interesting and meaningful to the students (p 11)." It is conceivable that teachers who are not sensitive to bicultural issues will not see statements such as these having implications for their programmes in terms of catering for the learning needs of Mäori students.

[1] for example U.S.A., Phillipines, parts of Canada, parts of Australia, New Zealand (pp 43 to 45)

Implementing Mathematical Processes (Ministry of Education, 1995) includes two case study activities relevant to year 9 that incorporate bicultural perspectives. One involves exploring the relationships between nga waka and tribal areas (pp 25 to 26), and the other involves exploring tukutuku patterns (pp 29 to 31). *Development Band Mathematics* (Ministry of Education, 1996) includes the koru shape in one small aspect of one activity that investigates the mathematics of spirals (pp 80 to 96).

These publications offer very few examples that can be used by teachers to enhance the bicultural nature of their programmes, or that model rich bicultural practice.

Since the study schemes were written, the Ministry of Education has begun publishing Tühono (published in Te Reo Mäori) and Connected (the English version of Tühono) (both from 1998). These are school journals which focus on mathematics, science, and technology. The Ministry of Education also administers a bilingual website (http://www.tki.org.nz) (Ministry of Education, 2000b) and a mathematics website that provides problem solving problems in both Te Reo Mäori and English (http://www.nzmaths.co.nz) (Ministry of Education, 2000a).

Other Sources of Bicultural Perspectives

Many teachers are challenged to find further examples of Mäori contexts that they can use in classrooms to better cater for Mäori children. However, there is a range of these in the literature, such as those found in *Te Kupenga*, *Mäori Legends in Maths*, Metge, (op cit), Barton (1990), and New Zealand Mathematics Magazine articles by:

- Knight (1984), on Geometry of Mäori Art;
- Bush (1988), on Numeracy; and
- Hughes (1989) and (1990), on investigative teaching using tukutuku patterns.

Study Findings

The fifteen schemes were analysed to find evidence of bicultural perspectives. Bicultural perspectives were defined as those having an identifiable Mäori aspect or bicultural emphasis. Three types were found:

- those with the activity title written in Te Reo Mäori;
- activities that were referenced to a Mäori craft; and
- activities that were referenced to a Mäori legend.

These three types were the *only* bicultural perspectives that were clearly identifiable in the schemes. There may be other bicultural perspectives referenced in the schemes that were not identifiable as such. For example, these could occur in lists of textbook references, or because bicultural activities were referenced by European names in the scheme. Most learning experiences within the schemes were referenced by a title or text book reference only. This did not allow accurate analysis of either the mathematical or bicultural content. Therefore the bicultural perspectives that are presented here should be seen as the *minimum* number of bicultural references within the schemes rather than as totals.

Classroom programme aspects consistent with a bicultural classroom such as the inclusion of group work, practical activities, and oral work, are difficult to measure in the analysis of written planning, and therefore were not explored in the study.

Of the fifteen schemes none included statements within their introductory section regarding either awareness of bicultural issues or performance differences, or of incorporation of specifically bicultural perspectives into classroom programmes[2]. However the third sentence of one scheme stated:

> "It is the responsibility of the individual teacher to select activities appropriate to the abilities, interests and cultures of their students."

For eight of the fifteen schemes, no bicultural references at all were found. Of the seven schemes that did include bicultural perspectives, three had only one reference. The school with the most inclusions (ten inclusions) was a school with over ninety percent Mäori students. This was the only school for which the most recent Education Review Office report included a statement regarding the

[2] However it is possible that such statements are made within an overarching departmental management document, rather than within every department scheme.

inclusion of Mäori perspectives in mathematics *planning*[3]. The report stated that "the Mäori perspective is evident in the work plans, resource material chosen, and in displays (Education Review Office Report[4], 1998, p 8)."

The most recent Education Review Office reports for fourteen of the fifteen study schools included statements or recommendations that relate to the learning needs of Mäori students. These were statements made across curriculum areas rather than specific to mathematics. Two of these recommendations encouraged all school subjects to include bicultural perspectives into their programmes[5]. However, the fact that only one report commented specifically on Mäori perspectives in *mathematics schemes*, may suggest to schools that this is not an area that they need to address.

Table 1 shows that the few bicultural learning experiences found in the study schemes mostly fall within the Geometry, and Number strands of MINZC. All but three scheme references to learning experiences were brief and obscure, often listed as an activity title only. For example, 'Pütahi', 'Weaving patterns' and 'Köwhaiwhai' were listed within the symmetry topic without further description of the learning experiences. One scheme included activities, such as 'Tukutuku Patterns', and 'Koru construction' (shown in figures 1 and 2), with sufficient detail to enable teachers to use the learning experience without further explanation.

[3] Two other comments from the Education Review Office reports were specific to mathematics teaching and learning of Mäori students. One was a statement regarding the mathematics achievement of Mäori students; and the other that "mathematics teachers actively consider the needs of Mäori students."

[4] The Education Review Office report identifies the school and is therefore not listed in the references section of this report.

[5] Other report statements included comments on: the positive and effective way in which the school caters for Mäori students (5 reports); the lack of data on achievement of Mäori students (4 reports); and recommendations such as "implement present policies which acknowledge the unique place of Mäori…", review policy "regarding the management of Mäori education, in order to reflect National Education Goals 9 and 10 (10 reports).

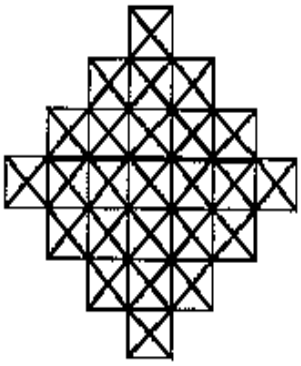
Table 1: Bicultural Learning Experiences in Study Schemes by Strand

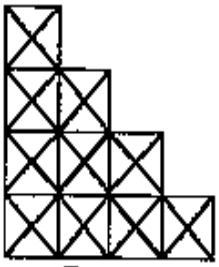
Content Strand of MINZC	**Learning Experiences** (as quoted from schemes. All macrons have been added where appropriate)	**Total Number of Bicultural Learning Experiences**
Geometry	Pütahi, Weaving Patterns, Köwhaiwhai (four schemes), Traditional Mäori patterns such as Tukutuku, Täniko, and Tïpare [MINZC p 112], Tïpare Mäori Legends – Reflection Mäori Legends – The Symmetry of Numbers Mäori Legends – Enlarging Matakauri Koru construction [MINZC, p 106], Koru Transformation geometry worksheet using the koru motif	14
Number	Use Mäori numbers to count, add and multiply, Ranginui – Papatüänuku, Maui and the Sun, Matau – Giant of Wakatipu, Retelling a Legend, Preparing a Hängi.	6
Measurement	Te Tinana, The Legend of Tupei Ra, Mäori Lunar Calendar [MINZC p 72], Mäori mako [sic presumably moko]	4
Algebra	Going to a Hui, Tukutuku patterns (includes pätiki, tapatoru and tapawha patterns)	2
Statistics	-	0
Total		26

The following three scheme excerpts, (Figures 1 – 3), were taken from the one study scheme that was explicit. Bicultural learning experiences referenced in other schemes were referenced by title only (as shown in Table 1).

Topic Algebra **Level 4A1**

Objective Sequences

Learning outcomes **Students will be able to:-**	Ideas or possible
A1 **generate patterns from a structured situation, find a rule for the general term, and express it in words;**	Tukutuku Patterns 1 The following pattern is the 4th Patiki (flounder). We have the same pattern on the brick walls at the end of some blocks.  Draw in your books the 1st, 2nd, 3rd and 5th patterns. Then copy and complete the table to find the number of crosses in each design. Pattern / Number of Crosses 1st 2nd 3rd 4th 5th 6th 9th Repeat the investigation complete with a table for the Tapatoru (Tapa = edge, toru = threet). The 4th Tapatoru is below. Repeat the investigation for the Tapawha (wha = four) pattern. There is a link between the Tapatoru pattern and the Tapawha pattern, what is it? (see diagrams on right)


Tapatoru

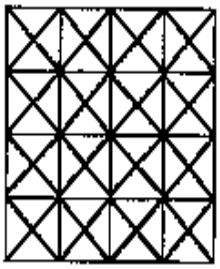

Tapawha

Figure 1: Scheme Excerpt - Algebra

Objective Constructions

Learning outcomes **Students will be able to:-**	**Ideas** or possible **Teaching Approach**
G2 construct simple geometric shapes using appropriate drawing instruments;	Construct Geometric Designs Moving with Maths Begg et al. pg 267 - 270 Construct a Koru. This can be done by following the instructions 1. Draw a base line about 18 cm long 2. Mark a point A 12 cm from the right end 3. Draw a quarter circle radius 10.8 cm starting above A and rotating right. label this arc BX 4. Draw a second arc radius 5.4 cm above A also turning right. Label this arc CD 5. Draw a semicircle centre C radius 5.4 cm ending at A 6. Find the midpoint of AC. label it E 7. Draw a semicircle radius 2.7 cm, centre E, from C to A. 8. You can shade in or construct enlargements of the Koru 
G2.1 understand and be able to draw angle bisectors, segment bisectors, and parallel and perpendicular lines.	

Figure 2: Scheme Excerpt – Geometry 1

Objective Symmetry

Learning outcomes **Students will be able to:-**	**Ideas** or possible **Teaching Approach**
G9 use the symmetry and angle properties of polygons to solve practical problems;	Apply to patterns, objects and design (frieze patterns, kowhaiwhai, wrapping paper, stained glass windows,)
G9.1 describe the reflection or rotational symmetry of a figure or object.	
G9.2 use the properties of regular polygons.	explore the three regular and eight semi-regular tessellations constructed from regular polygons

Figure 3: Scheme Excerpt – Geometry 2

Table 2 gives the number of bicultural learning experiences identified in each study scheme, the percentage of Mäori students in the school, and the school decile ratings.

Table 2: Numbers of Bicultural Learning Experiences in Year 9 Study Schemes

School Decile Rating	Percentage of Mäori students[6] in the School	Number of References made in the Scheme to Bicultural Learning Experiences
3	99	10
1	57	0
3	49	1
2	44	0
6	40	3
3	31	0
2	26	0
5	18	7
8	15	0
7	15	0
6	14	3
8	11	1
6	11	1
8	11	0
9	8	0

All but one of the schools with decile ratings from 3 to 6 did have bicultural material. Only one other school, (decile 8), had any such inclusions.

It was expected that the schools with the higher proportions of Mäori students would have the higher number of bicultural perspectives in the schemes. This was not always the case. This suggests that even those schools with a high proportion of Mäori students may be unaware of the literature and may be continuing to provide mathematics courses that are less accessible to Mäori students than to non-Mäori[7].

The school decile and the percentage of Mäori students are likely to be interacting factors that should be interpreted with caution. In general, mid-decile school schemes were found to have the greatest

[6] data taken from the most recent Education Review Office report for each school.
[7] The correlation coefficient showing the strength of the relationship between the percentage of Mäori students and the number of bicultural inclusions was 0.551 (3dp), which is insignificant at the 5 % level of significance.

number of bicultural references[8]. The high decile schools might typically have more time and greater financial ability to go beyond the basics in terms of finding and using teaching resources with bicultural perspectives, but if this is the case, it is not reflected in their schemes.

Research Questions

- *What is the (bicultural) content of year 9 mathematics schemes?*
- *How does this vary from school to school?*

The study schemes were generally light in terms of their bicultural emphasis. The data should be read with care due to: the small sample size; the insignificant correlations; the inter-related nature of the school decile rating and percentage of Mäori students; and the fact that over half of the sample schemes included no identifiable bicultural references (leaving only seven non-zero data values). However, the scheme from the school with the largest percentage of Mäori students does have the largest number of bicultural perspectives.

Discussion

A lack of reference to bicultural perspectives in a scheme does not necessarily mean bicultural perspectives are not incorporated into the learning programme. However, unless there are resources available to all staff, each individual teacher would need to decide how to incorporate bicultural aspects into their programme independently. This can place a heavy burden on the classroom teacher, particularly those new, or returning to teaching.

In the light of 1999 legislative requirements, it would appear that the majority of the study schools are not meeting the expectation of the Ministry of Education in the area of bicultural mathematics with respect to providing learning experiences relevant to Mäori students. It seems likely that many New Zealand year 9 children are not experiencing mathematics programmes that are rich in bicultural perspectives. Furthermore, this may be in marked contrast to other subjects such as Social Studies, English, and History and could suggest to students that mathematics is not a subject in

[8] The correlation coefficient showing correlation between decile and the number of bicultural inclusions is –0.141 (3dp) and statistically insignificant at the 5 % level of significance.

which Mäori students will feel comfortable. It may support the common belief that Mäori had no mathematics prior to contact with the European.

There may be several reasons why schools have been slow to incorporate bicultural perspectives into their mathematics programme planning. The bicultural emphasis of MINZC is new for mathematics curricula in New Zealand. Another factor may be that the comments regarding inclusion of bicultural aspects in programmes are in the introductory section of MINZC that might not have been read in depth by some teachers. The Learning Media handbooks *Developing Mathematics Programmes*, *Implementing Mathematical Processes*, and *Development Band Mathematic*s do not provide many examples of learning experiences that are specifically targeted towards the inclusion of bicultural perspectives into mathematics schemes or programmes. More recently the Connected/Tühono series and the Ministry of Education bilingual website *Te Kete Ipurangi* (http://www.tki.org.nz) (Ministry of Education, 2000e) have been providing more bicultural examples.

Possible implications of not making mathematics programmes more biculturally focussed include:

- Mäori students perceiving that mathematics is not a subject for them;
- the continuation of a performance gap between Mäori and non-Mäori students in mathematics; and
- less than optimum progress towards meeting the Ministry of Education's numeracy goals.

In order to enhance the bicultural perspectives of school mathematics schemes, scheme writers could target resources and learning experiences that have a bicultural emphasis, and write these into their schemes. Schemes could include lists of references to ways of using teaching and learning methods that the research suggests are conducive to a bicultural classroom. These include use of group work and oral activities. Indication of the relative use and importance of resources and methods, (such as use of textbooks, use of group work, and use of realistic contexts), within the scheme may also enhance the scheme's bicultural emphasis. This is consistent with Clark's (1998) concept of a 'comfortable classroom' where maths is less formal and competitive than has traditionally been the case, and where examples that are meaningful to the students are used.

A positive move nationally would be the creation of further accessible classroom resources such as a website of lesson plans using bicultural contexts and methods, or of good models of schemes showing integrated use of bicultural perspectives. This would be a very useful move to assist teachers to enhance their planning and teaching of mathematics, particularly in the light of the revised National Education Guidelines.

Further questions raised by this study include:

What would be the findings of a similar study into schemes from other curriculum areas?

What would be the findings of similar studies into the incorporation of *multicultural* aspects in school schemes?

Do schemes rich in bicultural perspectives lead to 'biculturally rich' classroom programmes?

What are scheme writers' knowledge of, attitudes to, and confidence in the use of bicultural and multicultural aspects in school schemes?

How can expertise in scheme writing be enhanced?

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