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Multicultural Aspects of Mathematics Teacher Education Programmes

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Many societies around the world have become increasingly multicultural in nature in the past ten years and while theories of learning often propound the concept that mathematical ideas are grounded in the social and cultural background of students and teachers, the extent to which teacher education programmes have kept pace with this changing social milieu is often unknown. This paper discusses the situation in seven teacher education centres in New Zealand, and assesses the influences on whether, and how, multicultural perspectives on mathematics teaching have been introduced into these programmes.

Socio-cultural theories, combined with elements of constructivist theory, have been a major trend in mathematics education research during the past decade (Cobb, 1994a), capturing the interests of many researchers. Constructivism, in its various forms, is a widely accepted notion that learners actively construct ways of knowing as they strive to reconcile present experiences with already existing knowledge structures. Arguments promoting constructivist theories in mathematics education have been advanced by a number of authors, including von Glasersfeld (1984, 1987, 1990) and Ernest (1991). The emergence of constructivism as a theory has increasingly been in the context of an emphasis on the socially and culturally situated nature of mental activity, with participation in social and cultural settings acting as a catalyst for cognitive development (Cobb, 1994b; Nunes, 1992; Lave & Wenger, 1991). Thus these theoretical perspectives suggest that different forms of knowledge emerge in different cultural settings in response to the needs and the problems faced by the people in a given place and time.

Efforts have been made to incorporate the advantages of this viewpoint into teacher training programmes, with several recent examples of teacher preparation programmes modelled on constructivist and socio-cultural theories. Although still in the early stages of exploration, work by Lampert and Heaton (1993), for example, has combined research on learning and research on teaching by looking at both through a sociological lens. They advocate a new pedagogy of teacher education that includes field experiences in which pre-service teachers have not only increased contact with teacher educators, but also the opportunity to grapple together with the deep and perplexing challenges of mathematics teaching. This approach to teacher education includes "a practice-centered process of learning to teach where the actual problems of practice are central, where the question of what it means to know and learn mathematics shapes the discourse, and where analysis and action are integrated in ongoing work with students" (Lampert & Heaton, 1993, p. 46). Presmeg (1998) also reports on the need for a culture-inclusive course for both prospective and practising teachers, describing how such a course can stress the students' ownership of personally meaningful cultural mathematics.

A third example of socio-culturally based teacher preparation exists in the work of Cochran-Smith (1991). In programmes reflective of collaborative resonance, Cochran-Smith suggests that "reinventing student teaching is to link what students learn about teaching from their field-based school experiences through mutually constructed learning communities" (p. 109). The assumptions that guide programmes of this nature include more than simply teaching student teachers how to teach. Rather,

> It is teaching them how to continue learning in diverse school contexts by prolonging and intensifying the influences of university and school experiences. Programs based on collaborative resonance simultaneously aim to capitalize on the potency of teaching culture to alter students' perspectives by creating or tapping into context that support student teachers' ongoing learning in the company of experienced teachers who are actively engaged in efforts to reform, research or transform teaching. (p. 109)

Thus it is often recognised that educating the pupils mathematically is more difficult, challenging and complex than teaching them some mathematics (Bishop, 1988).

The continuing debate over the epistemological nature of mathematics is relevant to teacher training too. Mathematics is still considered by many to be a neutral and value free discipline, but if it is socially constructed as a part of culture, as Frank (1990), Thomas (1997), d'Ambrosio (1997) and many others maintain, then the role of alternative cultures becomes a vital consideration. Some evidence for this view has emerged from word problems that have historically represented very concrete and complex cultural, social and economic relationships (Cohen, 1982; Swetz, 1987, 1992). Steinbring (1998) discusses the importance of epistemological knowledge of mathematics in social learning settings and his analysis suggests three important components that could be introduced into mathematics teacher education, namely: (a) the developmental nature of mathematical knowledge, (b) interactive social processes of mathematical communication, and (c) the interdependence of social and epistemological constraints in mathematical communication. D'Ambrosio (1997, p. 246) maintains that multicultural opportunities for teachers are very common, "In the daily practice of the school teacher, opportunities for experiencing multiculturalism abound. ...What can the teacher do in this situation? From the multicultural standpoint the teacher can learn from the student."

This context, an increasing number of multicultural countries around the world (Gerdes, 1998), suggests a need to revisit teaching practice, and in particular teacher training programmes, in the light of society's multicultural context and ask whether teachers are being prepared to be active participants in the multicultural classroom. Bishop (1985) has provided a rich framework of ideas with which to explore this area, focusing on sharing and developing mathematical meaning between teacher and students and among students themselves. This of course involves language, which in turn is related to the social, linguistic and cultural background of the students.

The purpose of the present study was to initiate a process of examining the ways in which mathematics teacher training programmes in New Zealand are responding to the changes to a modern multicultural society.

The Study's Approach

New Zealand, like Australia (Thomas, 1997), is no longer a simple bicultural society of Maori and Pakeha (the Maori word for white, non-Maori). Apart from Maori, and Polynesians such as Samoans, Tongans and Niueans, recent New Zealand immigrants come from many countries and exhibit an enormous linguistic and cultural diversity. Sometimes, even after many years in New Zealand, English is still very much a second language used only when necessary, with their mother tongue spoken in the home and community as much as possible. Increasingly, this cultural and linguistic diversity is being recognised as a rich resource (Holmes, 1982) and schools have become aware that they cannot satisfactorily provide for these children by ignoring such differences.

However, it has not been at all clear what steps have been taken by providers of mathematics teacher training to prepare teachers to work in this multi-cultural environment. Thus we considered it timely to study the secondary mathematics teacher education programmes within New Zealand, and the beliefs and practices of teacher educators underpinning them, with regard to multicultural contexts, with the following objectives:

- To ascertain the beliefs of the teacher educators in the secondary mathematics teacher education programmes about the value of a multicultural dimension.
- To gather teacher educators' views about the current strengths and weaknesses of their secondary teacher education programmes with regard to multicultural issues.
- To collect suggestions from teacher educators about possible ways to introduce a multicultural dimension into secondary mathematics teacher education programmes.

Participants

The northern part of the north island of New Zealand, from Waikato north, has a large multicultural population, and so it was decided to include all the secondary teachers' training institutions in this area. In addition one institution was considered from Dunedin that has a mostly monocultural trainee population. All seven of the teacher education institutions within the northern region were approached for permission to survey the teacher educators involved in training secondary mathematics teachers. While all the institutions were agreeable it was apparent that our approach to the teacher educators about multicultural initiatives had touched on a sensitive area. In one large centre not one of the educators was willing to participate, and in another two we had to field serious concerns before

being able to elicit responses. Hence we ended up with a sample of seven educators from six teacher education institutions consenting to participate.

The Survey Instrument

Data were obtained in the form of responses to a short questionnaire comprising ten items (given in full in Figure 1) and in addition the respondents were given the opportunity to be interviewed. However, only one person, educator C, took up this option. Her 45 minute unstructured interview was primarily based on her responses to the survey instrument and sought to illuminate the issues she raised in the light of her own experiences at the teacher training institution where she works.

1. Do you think that the sociocultural dimension of a multicultural society should be introduced while educating mathematics teachers? If so, why do you think so?
2. If you answered 'yes' above then please suggest how it could be introduced in an education programme of secondary mathematics teachers?
3. There are primarily two dimensions, which the teacher educator may take into consideration during an education programme for secondary mathematics teachers. These are (i) the sociocultural background of the student teacher and (ii) the sociocultural background of the secondary school students (within a particular society). Please opine whether teacher educators should consider either or both of these dimensions during the training programme. Give reasons for your answer. If possible give illustrative examples.
4. Do you introduce any specific aspects relating to the sociocultural dimension of society or of your students during the programme? Please give a detailed explanation of what you do and how.
5. Please give your views on whether the programme of secondary mathematics teacher education at your institution caters to the multicultural needs of New Zealand society. If not, please describe any weakness in your training programme in the context of the needs of a multicultural society.
6. Please describe any interesting situation/events that you have observed /come across during work with student teachers that contributes to the argument for or against introducing sociocultural aspects into teacher education programmes.
7. Please state the merits and strengths of your programme in the context of the needs of multicultural society.
8. Do you follow any specific model/combination for educating secondary mathematics teachers at your institution? Please give details.

9. To what extent do you have input into the content of the teacher education programme at your institution?
10. Do you feel that your own background influences the educating of your student teachers? If so, how?

Figure 1. The ten items in the questionnaire.

Results

The responses to question one showed that all the respondents except one, F, believed that it is important to introduce multicultural ideas into the education programme of pre-service mathematics teachers. Educator F gave as his reason for disagreeing, "Because the principles of the mathematics transcend socio/political/cultural/economic/gender/sexual considerations." Reasons why the others thought such concepts should be included were:

A: As we live in a multicultural society, sociocultural issues cannot be ignored or assumptions made.

B: It is particularly important that some exposure, reflection, awareness and development of approaches to cater for the rich range of sociocultural background our children come from is part of their programme.

C: To equip teachers to cope in a multicultural society.

D: If teachers do not have an awareness and empathy for students of the different cultural groups and their positions in society, it is not possible to meet individual needs.

E: It is an integral part of any teacher education programme… (i) Many learning theories highlight the fundamental nature of the sociocultural dimension on what is being learnt and how it is learnt? Therefore can't be avoided. (ii) Teaching is a profession and so cultural and political aspects are some of the fundamental dimensions of professional knowledge of the teacher.

G: To appreciate how and why children learn and the context of schools.

In her interview, educator C enlarged on her response about assisting teachers to cope. Her emphasis was particularly on the language problems faced by new immigrants to New Zealand.

> I think to me a key, because you look at a group each year that have been multicultural, there have been a number of cultures in the same group and the reason I think it's an issue is, I think that some of the cultures have more voice and some of the cultures feel disempowered because they're in a new country and so to me there's a strong issue here of people who think that because they don't speak English that what they have to say is not worth as much as if they were speaking say, in English ,and that people who assume that because somebody else can't say something to anyone in English that what they're saying doesn't have value, to me that's very important. And it's a really important thing in maths because each year half the group have been in English as a second language and so that's really, really important and if they don't feel that what they're bringing is of value then

> they're not going to function as teachers. And I focus on making them feel valued in the hope that the class will see that they should make everybody feel valued in their class so ----. That's my aim to give them a voice.

Her aim seems to be to place an object lesson before the prospective teachers of valuing each others' differences so that they will then value the diversity in their school students.

Four were able, in response to question six, to give anecdotes from within their personal experience that supported this perceived importance, including some focus on it during the interview. For example, one told of a trainee teacher, an ex-professor of mathematics from India, on practice at a rural, 95% Maori, low decile school who was struggling to make a connection with the children, and them with him. Two others talked about the issues related to immigrants, with one describing how some seemed to be 'escaping' from experiences where culture had been a source of conflict and consequently found the issue challenging to their own philosophy, and another talked about experiences with three student teachers from two countries who seemed to be unmovable from their position of an unwillingness to accept that different cultural needs can or should be met. In her interview, C talked about a student from the former Soviet Union:

> when they give a maths problem in and they get it back what they expect to get is they expect to get all those mistakes underlined and highlighted and what they want to be told is what they've done wrong so that they can fix that. And my observation is they seem to have trouble accepting positive response to work. And in general that it makes them anxious when somebody says something good about things, because they want to be told how they can fix those things that are not right. And I think that makes life very difficult for them.

However, in spite of a strong leaning towards the importance of the multicultural dimension of teacher education, they admitted (in response to question four) that they formally introduced few, if any specific aspects relating to the sociocultural dimension of society during their training programme. Instead these aspects were left as "…part of the reflection we do on activities and teaching practicum experiences", or students are encouraged to "look at their own epistemology and then review it in the light of ethnomathematics. Students also intentionally observe the learning of pupils on their practicum." Similarly, the issue was sometimes left to arise via "discussion and analysis of the place of Treaty of Waitangi in schools." One of the programmes had "introduced an introductory week for non-NZ educated students to expose them to some 'taken for granted' aspects of NZ culture." Similarly, some of the centres made an effort to address the issues by bringing in outside speakers to talk with the students.

The teacher educators surveyed were also able and willing to identify some weaknesses in their programmes in this area, stating:

> A: [We] have only a limited number of context and approaches that I use when modeling teaching, e.g., patterns for algebra, Maori numbers used in mathematics games.
>
> B: Probably due to the nature of the community in this area [our programme is] not strong in Pacific Island, Asian or European perspectives.

D: [Our programme] does not cater for multicultural needs but is primarily catering for bicultural needs.
E: We only look at Maori and Pakeha learners with little attention given to the broader range of cultures within NZ.
G: Different issues - different areas of New Zealand may not be fully considered.

The question arises then as to why, if they perceived the multicultural work as an important part of mathematics teacher education, none of their programmes formally addressed it, and few spent more than a small amount of time on it. The answer was not that control of the programme was out of the hands of these educators. When asked about the extent of their input into the content of the teacher education programme at their institution (question nine) most of them said that either they wrote the programme ("A great deal. I wrote the course outline"; "Course is of my design"), had total control over it, or the "major responsibility" for its content. Only one was under the control of an 'advisory committee' and felt able only to implement minor changes to the programme, while one other worked in close collaboration with another colleague.

They did outline a number of reasons for the lack of a strong multicultural element in their programmes. One of these which was conveyed was the political pressure in New Zealand society to stress biculturalism. Comments from A and D stressed this perspective:

A: However living in NZ and teaching in a bicultural society I have had my own beliefs and prejudices (Q10).
D: In this geographical region it tends to be more a bicultural dimension (Q1); No, it does not cater for multicultural needs but is primarily catering for bicultural needs (Q5); The treatment of biculturalism has been beneficial to our student teachers (Q7).

Furthermore, C mentioned the political side of the multicultural issue as she saw it in her interview "…it is a complicated issue especially for a country that I think fundamentally believes is told that it's bicultural and believes that perhaps with their heads but I think in their hearts, New Zealanders are monocultural…There's a political dimension of it." The political implications of this strong historical link to a bicultural society may be one reason why multicultural education is being formally held back. A second reason given by the respondents as to why it has not been implemented was their own personal experience and background on such issues.

A: The main weakness is the lack of experiences on my part of teaching in strongly multicultural settings… Growing up in [another country] my own background inevitably influences my views and the way in which I teach!… I do believe, however, that I lack much understanding and knowledge that would be desirable.
D: Yes, in fact that I am not fluent in Te Reo and as such can never be fully aware of all issues in a bicultural situation.
E: I often struggle to empathise with other perspectives being a middle class pakeha [i.e., white non-Maori] male who was relatively successful mathematics learner. Through reading, research and discussion I try and see mathematics and mathematics education through the eyes of others.

G: I bring my own s/c [sociocultural] background and perspectives to what I know and can teach.

C felt that the experience of being an immigrant was a positive factor, saying "I believe being aware of strains placed on being an immigrant makes me more sensitive to the problems immigrants face." A second factor described as contributing to the lack of a formal approach to multicultural issues was a lack of time. This is exemplified by the comment from respondents E and F that "Time is the major factor - one year to address too many professional issues." and "I am thereby enabled to maximise time resources necessary to get across the principles of mathematics teaching." The limited variety of cultural background in their intakes was a reason given by E ,"We do not have vast number of students who are anything other than Pakeha, so the sociocultural make up of our intakes are narrow."

Two of the educators decided not to approach multicultural issues feeling that they are best dealt with in generic parts of the teacher education programme, rather than in the subject specific mathematics part:

F: The institution in which I work already covers these aspects in various courses.
E: Students study educational history, learning theory, Maori and multicultural studies as part of their teacher education.

F stood out as the only one who gave as a reason for not addressing the issues the idea that it was the mathematics that should be the focus of the teacher education, citing US experiences to support this perspective:

> While a defensible case can be made for including these dimensions, there is good evidence from inner-city ghetto schools in USA demonstrating that where the primary focus is on the subjects matter (i.e., mathematics) rather than on these social dimensions.

On the one hand all of these teacher educators except F believe strongly in the introduction of multicultural aspects to the teacher education programme (but are not able to do much in this regard for the above mentioned reasons), and say that they recognise the importance of both the trainee teacher and the school student dimensions in their teacher education programmes. On the other hand most of their comments focus on the teacher trainee side and seem to imply that they are not catering fully to the needs of the students who are learning in the multicultural environment existing in New Zealand schools.

Several of the teacher educators described the strong leaning of their programme towards educational theories, especially some form of constructivism.

A: We are very much focussed on curriculum issues in mathematics. As NZ curriculum is written in constructivist terms this is the approach that we are advocating and modelling.
B: We in general model a social constructivist approach with mathematical activity generally investigative and then reflection.
C: It is a research based model, which attempts to weave practical experiences, theoretical experience, reflection and one-on-one support into a supportive, challenging experience.
E: based on constructivist notion of learning.

G: I have a situated/sociocultural view of learning.

These positions tended to contrast with F's theoretical view that mathematical principles transcend sociocultural considerations.

> While recognizing the sociocultural diversity of my student teachers and their students, I believe the strength of my training programme lies in recognizing that a solid grasp of mathematics is a unifying force in human affairs which transcends sociocultural diversity.

The educators also used recourse to arguments based on theories in their other responses. E thought that "Many learning theories highlight the fundamental nature of the sociocultural dimension on what is being learnt and how [it] is learnt", and that the concepts could be introduced via a "Learning theory, e.g., social constructivism." G believes that sociocultural dimensions of mathematics are "consistent with constructivist views of learning." D considered a way to introduce multicultural ideas was "During teaching practice this should be trialed and reflected upon to discover the discrepancies between theory and practice", and C commented that "sometimes the input needs to be more theoretical as the experiences are not as readily shared."

In spite of the strong resonance of these descriptions of a theoretical stance encompassing ideas which embrace sociocultural views of teacher education, they did not seem to translate into formal action in the programme. One possible reason for this was mentioned by G who spoke of how the "challenge is to find NZ based research and innovation within the area of mx [mathematics]."

However, in spite of the restrictions they are under when it comes to implementing educational perspectives on sociocultural issues, some good suggestions emerged from the teacher educators on what can be done within such constraints. These include introducing contexts and activities relevant to a range of cultures and learning styles throughout the mathematics programme. G thought that since "sociocultural diversity is often present within a class", it is good to introduce the issues through shared experiences and views. C agreed with this approach:

> In a group of students which has a range of cultures represented, some of whom may feel more or less marginalised and empowered. In the current situation, I think the first thing to do is to validate everyone's prior learning, e.g., with respect to language. However it also needs to be made possible to discuss the fact that certain cultures are more representative of the school system and the country.

She explained further in her interview an activity she uses to get across respect for others' language and culture and to help understand the disempowering effect of not understanding a language.

> The very first activity I do with them at that point is… I put them into groups where one person at least is non-English speaking. and get that person to teach the other two a nursery rhyme which…give them an English nursery rhyme which they translate into their mother tongue and then they teach to these two so that the people who don't speak Chinese and the people who don't speak Tongan are disadvantaged, just to sort of do a little role reversal right at the beginning of the year, and that works really well.

Other suggestions included B's idea that, "the strengths and learning needs of all student teachers need to be analysed and developed on an individual basis." This is obviously important, but does not rule out the group approach. To encourage reflective thinking and practice it was D's proposal that one could instigate "a 'generic' study of the groups who make up the local society. Generalizations of groups form a good beginning to cause thought and analysis." Study of the nature of mathematics itself was identified by E as a valuable contributory area:

> It is important to intentionally address the claims of ethnomathematics and the 'human' character of mathematics, as many pre-service teachers mathematical epistemology may be contrary to this. …You also need to address the sociocultural dimension of mathematics itself. The background of the teacher will be largely influential on their belief about mathematics, mathematics learning.

These ideas, addressing our third aim in the study, suggest possible ways to introduce a multicultural dimension into secondary mathematics teacher education programmes and are helpful in assisting this process.

Conclusion

The above analysis of the responses to our small-scale survey seem to indicate that there are no formal specific guidelines available in terms of a particular model or approach for New Zealand secondary mathematics teacher education programmes in the light of its diversified cultural society. Instead, the positive, highly sensitised teacher educators, who have a high degree of control over their programmes, select the resources and approaches which best fit into the system where they work to justify their teaching in the context of the group whom they teach and society at large. However, they do not appear to use specific resources developed for the multicultural classroom (see e.g., MacGregor & Moore, 1991, cited in Thomas, 1997), even though it must be acknowledged that these are still not common. Gerdes (1998) has highlighted the need for teacher education programmes to develop among prospective mathematics teachers an awareness of what many see as the social and cultural bases of mathematics through the process of reflection, and this is certainly one of the methods used in the programmes we investigated. While the teacher educators strongly perceive their education programmes to be constructed in the light of social learning theories such as constructivism, multicultural aspects of this do not feature strongly. For example, there was very little mention of the use of the kinds of readings in the literature one might expect, such as those listed by Thomas (1997, p. 35) which she describes as "available to help teachers develop a theoretical framework for the linguistic and cultural aspects of mathematics education."

Although the educators in this research have a strong awareness of the multicultural nature of New Zealand society (Kincheloe & Steinberg, 1997) and possess a range of experiences in the teacher education field, they accept that they have limitations due to their own cultural background. A conclusion of Bohn (1999) was that individuals base their conceptualisations and practices of multicultural education on their own life experiences, and if these afford them a deeper

understanding of minority issues then they may possess more advanced conceptions and practices. The present study presents some evidence which seems to support this viewpoint, with immigrants among the educators appearing more acutely aware of certain issues. Irrespective of their cultural background and work place (either with strong representation of multicultural or monocultural population), most of them valued a multicultural dimension in a teacher education programme and had some good, clear ideas on how sociocultural issues in a diverse multicultural society like New Zealand could be approached. There are recent studies, for example, suggesting that the use of narrative and narrative enquiry in teacher education can change perspectives and practice of prospective teachers (Igwe, 1999) and such an approach could prove useful in mathematics. Given the time and resources these educators are clearly capable of beginning the process of constructing a programme with a formally integrated multicultural strand, but may need an incentive to do so.

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