Chapter 8
The Politics of Equity and Access in Teaching and Learning Mathematics

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Abstract Besides clarifying the definitions of equity and access we briefly contrast two philosophical positions on the nature of mathematics and speculate about their consequences for equity and access. We next discuss "whose mathematics," and provide a viewpoint for mathematics learning as related to equity and access for students. We also consider mathematics teachers and their teaching role as these are related to equity and access for students, and then broaden the chapter to include political influences on both teachers of mathematics and learners. Given the diverse political systems in operation throughout the world, and the range of conditions within and between countries, we are unable to frame questions that can be definitively answered. Our observations relate to the role that politics plays at different levels to influence access and equity for teaching and learning mathematics and are supported by particular examples, some from history, others documenting more recent events. Finally we offer a brief discussion of several international cases of what we believe is a form of colonization that follows from official insistence on "English first" in teaching mathematics in some states where English is a second language for students.

Equity and Access

So far as mathematics education is concerned, access and equity are mostly concerned with whether a complete range of mathematics courses is available at the school level to satisfy the needs and demands of every student and the degree

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to which that access remains open to intending students provided that student performance is satisfactory. So for mathematics learning to be equitable and accessible, all students, regardless of social and cultural background, gender, religious beliefs, ethnicity, geographical location, and family financial circumstances, should have the same "opportunity to learn" (OTL) mathematics (Husén, 1967). For Husén, OTL was the degree of overlap between content taught and content assessed. Classroom conditions, curriculum decisions, teacher beliefs about mathematics and about which students can learn mathematics, teacher preparation in mathematics, and teacher knowledge of effective teaching strategies are factors not considered in OTL, nor are factors that operate to make the content differentially accessible for different students.

A seemingly direct way to make some assessment of the access part of equity and access is to collect information on the provision of mathematics courses, particularly at the high school level. The premise that supports this approach is that without the opportunity to take courses beyond basic arithmetic and elementary level mathematics, students will find it difficult to continue on to mathematics and science courses at upper secondary school that are necessary for success at the college or university levels. Assessing participation rates of different socio-economic and ethnic groups of students within a particular school in those advanced mathematics courses that are provided should generate a second measure of access and equity. These data may be disaggregated to allow comparison not only between countries but also between subpopulations within each country and at the state or district level as well. Of course, performance within courses is an important component of access. At the secondary school level, if the performance of a particular student in required mathematics courses is assessed by teachers as being not up to some specified standard, then further access to mathematics for that student may be quickly closed-off. In almost all countries, performance in secondary mathematics courses acts as a gatekeeper, not only limiting access to further school mathematics courses, but also limiting student choices in higher education. In only a small number of countries is it the case that students who are prevented from moving on in mathematics may re-enter their studies of mathematics as adults.

Data from a variety of sources including international tests (such as PISA, TIMSS), national tests (such as SAT in the USA) and local tests (for example, the state-imposed NCLB-mandated tests in the USA), on both access and performance, are currently collected and examined by a correspondingly broad range of groups with particular interests in education: school administrators, educators, members of policy groups and politicians. For example, Akiba, LeTendre, and Scribner (2007), after reporting the 2003 TIMSS data from 46 countries on student access to qualified teachers, noted the not-surprising outcome that access to qualified teachers was positively related to student performance. However for the USA, which had similar teacher quality to other countries, there was a large gap in access to qualified teachers for low-SES students compared with high-SES students. By contrast, Korea, which had a much higher rate of qualified teachers and higher student achievement in comparison with the USA, still had a substantial achievement gap between the high and low-SES students. That suggested that qualified teachers alone may not be able to overcome the effects of low-SES.

Another example of international comparisons of mathematics performance is provided by the surveys conducted by the Programme for International Student Assessment (PISA). Comparative data have been collected, analyzed and published by the Organization for Economic Co-operation and Development (OECD), a forum of some 34 countries whose mission, according to its Web site (http://www.oecd.org/pages/0,3417,en_36734052_36734103_1_1_1_1_1,00.html), is "to promote policies that will improve the economic and social well-being of people around the world." PISA has been conducting its tests of reading literacy, mathematics literacy and science literacy every 3 years since 2000. The latest mathematics results are of data collected in 2009 from a sample of 15-year-olds selected in participating countries (OECD, 2010a). These data allow many comparisons to be made within and between countries by educational researchers and educational administrators. For example, rates of participation and performance outcomes of males in a range of mathematics tests and courses are compared with those of females; and rates and performances for those same courses and tests of different minority groups are compared with those of other minorities and of course with the rates and performances of the members of the dominant group. Measures other than achievement can also be made—with analyses of measures of variables based on ethnicity, socio-economic status, geographic location and similar characteristics providing a wealth of data allowing comparisons at international, state and local levels (OECD, 2010b, 2011).

International comparative studies (such as TIMSS, PISA) have established performance gaps of different kinds; for example, gender, Black versus Caucasian, Latino versus Caucasian. Much energy has gone into devising ways to close these gaps (NCTM, 2005). The other longer-term aspect of access and performance is their possible influence on opportunities for individuals in the future, which may lead to improvement in the economic, intellectual, and social lives of those with strong performances and a corresponding downturn in life chances for those with mediocre or poor performances.

Equity has found expression in terms of keeping track of performance within and between diverse groups identified by such considerations as, for example, gender, socio-economic status, and ethnicity (including minority language speakers). In mathematics education, a great deal of ground-breaking work, over many years, has established gender and ethnicity as attributes worthy of continuing consideration (see, e.g., Fennema & Leder, 1990; Fennema & Sherman, 1977, 1978; Forgasz, Leder, & Kloosterman, 2004; Reyes & Stanic, 1988; Secada, 1990), and the impact of poverty as a negative correlate of performance (Bracey, 2009; NCES, 2010) is also well-documented. The USA has one of the highest rates of childhood poverty among industrialized nations, a situation that raises issues concerned with equity and access for many US students.

Notice that poverty is not an attribute of individuals; it is rather a condition of their existence that leads to secondary consequences. Poverty is often accompanied by debilitating effects for young children, and these effects can compromise almost all attempts to achieve greater equity and access to education in general and to mathematics education in particular. But our lens must also bring into focus ways to decide upon the most appropriate nature of the mathematics into which young children and older students are to be inducted.

The Added Dimension of "The Politics of …"

The *Oxford Dictionaries Online* (http://oxforddictionaries.com/definition/politics) offers a set of meanings for the word "politics." In particular, there is one broad, neutral meaning—"the academic study of government and the state"—and a second meaning associated with "The politics of …." This second definition is: "The assumptions or principles relating to or inherent in a sphere, theory, or thing, especially when concerned with power and status in a society." At a more contentious level we read a third definition: "Activities within an organization that are aimed at improving someone's status or position and are typically considered to be devious or divisive." In this chapter, all three definitions will be relevant to our purposes.

The first is relevant because government-funded schools, as the designated sites for educating the majority of those soon to enter the general society, are institutions established by the state with functions and roles subject to state regulation. The state has political authority over these functions and roles, and that authority is codified in laws and statutes. At the base of these laws and statutes is a set of assumptions and beliefs about the purpose and nature of education. The school is the instrument intended to ensure that those graduating from it will in some sense be prepared to participate in the society envisioned by those in power.

In practice this is highly problematic. Assumptions about education and its purposes are varied and always contested by political groups and individuals within any citizenry. We all want our children to get a "good education," but there are within any one country very different images of what that means—negotiating which notions of the good are to guide the provision of education brings us to our second definition of politics as it applies to mathematics education—politics consists of those "assumptions or principles relating to or inherent in all *aspects of mathematics teaching and learning*, especially when concerned with power and status in a society." Each generation is inducted into a world that is adopting new layers of technological complexity; schools in the developed world are currently educating students all of whom have always known the Internet. Many of these students will find employment in fields or roles that are yet to be invented. The traditional argument that someone or some group knows what basic mathematical knowledge and skills will prepare students for their roles in society rings hollow when set against these realities.

Two commonly-held positions on education and the importance of learning mathematics may be labelled for our purposes as the *utilitarian perspective*—that only those mathematics courses that prepare the student for the world of work are necessary—and the *liberal perspective*—that all students can learn mathematics and individuals should be encouraged to pursue those mathematics courses that will allow them best to develop their own lives and careers. Of course, this is an oversimplification. Ernest (1991), for example, pointed out that each perspective will be enacted within a range of different groups with very different rationales and educational aims. The essential point is that the position held by those with responsibilities for political action may influence equity and access to mathematics, as well as the kind of mathematics education that should be supported as part of public education.

The utilitarian perspective may be described as conserving the status quo, but the political solutions offered by the liberal or humanist perspective are aimed at transforming society through the emergence of individuals who have sought their own pathway and who will bring new insights into problem solving. Somewhere between the two ideals, utilitarian and liberal, can, perhaps, be found the politics of the practical as the small numbers of the highly influential negotiate with the masses whose members each have limited individual power in the continuing struggle between different classes. How do these negotiations influence educational realities when considering the mathematical education of students and the preparation of their mathematics teachers in different societies?

What Mathematics? Whose Mathematics?

This is not the place to undertake a full discussion of the range of philosophical positions that may be taken on the nature of mathematics and the relationship of those positions to possible beliefs about mathematics education (Ernest, 1991). Our purpose here is to contrast two general perspectives and speculate about their consequences for equity and access.

Those holding a political position that we will continue to describe as utilitarian tend to perceive mathematics as neutral and uncontroversial, but those holding a more liberal perspective are likely to take an entirely different view of the nature and role of mathematics, for individuals and within society. To make the distinction clearer, let us consider the following comparison of positions on the nature of mathematics. It should be emphasized we do not intend to suggest that commentators who offer what we describe below as an example of what it means for mathematics to be neutral are therefore utilitarian in their political stance. The same disclaimer holds for those whose viewpoint exemplifies the liberal political perspective on the meaning of mathematics. In the interests of full disclosure we, the authors, declare ourselves to hold a liberal perspective.

At the Research Pre-session of the April 2010 meeting of the National Council of Teachers of Mathematics (NCTM) in the USA, a symposium entitled *Keeping the Mathematics in Mathematics Education Research* was held. This symposium came close on the heels of an editorial in the March 2010 issue of the *Journal for Research in Mathematics Education* (Heid, 2010) in which the editor stated that "*JRME* publishes research in which mathematics is an essential component rather than being the backdrop for another area of inquiry" (p. 103).

After reporting their impressions of part of the NCTM symposium, Martin, Gholson and Leonard (2010) reacted very strongly to some of the statements made during the symposium in relation to mathematics and the neutrality of the questions about the relationship between mathematics and mathematics education. Some of the words that drew their reaction were in the published symposium summary: "… the session addresses a growing concern among many mathematics education scholars regarding the lack of attention to mathematics in much of the current work in mathematics education" (NCTM, 2010, p. 60). Guershon Harel (2010) offered questions during the symposium about the role of mathematics in mathematics education research that he claimed were neutral and apolitical. This claim led Martin, Gholson and Leonard to present a strong case for the political and cultural nature of all mathematics and all mathematics education research.

The editorial comments by Heid, and the statement by Harel, had political implications for access and equity to mathematics teaching and learning—and also for what should count as research in the field of mathematics education, including mathematics teacher preparation and inservice development. Martin, Gholson and Leonard wrote:

> To whose mathematics are Heid and Harel referring? Is it the very same school mathematics that has been used to stratify students, affording privilege to some and limiting opportunities for others? … Mathematics can also be used as a tool for understanding the work and, in the case of marginalized students, it can aid in understanding the social forces that contribute to their marginalization. (p. 14)

To rephrase: A critically aware approach to mathematics may help those who are marginalized to understand how their marginalization came about and it may also provide opportunities to resist that marginalization. Strong support for the position on mathematics outlined in the above quotation may be found in Bishop (1988), D'Ambrosio (1985), Mellin-Olsen (1987), Powell and Frankenstein (1997), Skovsmose (2010), and many others. Contributors to the edited collection, *Ethnomathematics: Challenging Eurocentrism in Mathematics* (Powell & Frankenstein, 1997) provided strong arguments for this position.

The plight of smaller nations, struggling to survive in the swirl of world-wide globalization, provides a case in point. Later in this chapter we will outline some of the unintended consequences in several nations that have taken the political decision to require that all education, including the teaching of mathematics, be conducted in English only. We believe that this is an extreme form of marginalization, bordering on a form of neo-colonization, that is taking place with the tacit agreement of local politicians and administrators. The prevailing course of action in those nations is almost universally to adopt existing textbooks from the USA or Britain, and the result is that there is little local cultural input into the mathematics that is taught. As a result, the mathematics in the curriculum can be irrelevant to much of the daily lives of students in those nations. How likely is it that students in such a situation will come to see mathematics as a tool that allows them to understand their marginalization and attempt to do something about this neo-colonization?

So we question whether students in small nations with highly-developed sets of cultural practices and long-established languages should be required by political fiat to undertake their entire education in a language other than their first language. Should teachers in those nations be required to teach only in a language that is, for many of those teachers, a second language?

As we discuss equity and access to mathematics education across nations we will assume that the mathematics with which students should interact should be in a form that is relevant and meaningful to their lives, not only in an economic sense but also in a more holistic culturally-appropriate sense (Bishop, 1988).

Equity and Access for Students: A Developing Viewpoint

Earlier, we indicated that we would refer to more recent approaches to defining equity and access in mathematics education. Nasir and Cobb (2007) reminded us that the meanings of these terms are neither fixed nor transparent to all who are interested in ensuring that students enjoy every opportunity to participate successfully in mathematics beyond rudimentary levels. Not only do the concepts continue to evolve within the mathematics education community, but so too do mathematics educators' understandings of how they relate to mathematics learning.

Nasir and Cobb (2007) sought to reframe common understandings of access and equity by pointing out that although earlier reports on the constructs were made within an environment that accepted that culture and other factors were in play there was not, at that time, a deep recognition of their effects. They were treated merely as background factors. This is not to say that those conducting the studies were not aware of cultural impacts, but rather to suggest that the analyses were insufficiently sensitive and unable to treat these impacts in a functional way.

Nasir and Cobb's (2007) perspective raised the need to understand culture and its impact, and to generate more productive ideas by applying "sociocultural theory [which] provided us with not only a common language, but also with a toolkit of ideas that potentially offered important insights into long-standing equity and diversity issues in mathematics education" (p. xi). We recognize a parallel to the concerns expressed by White, Altschuld, and Lee (2006) that are discussed later in this chapter. In particular, we recognize that those students belonging to a cultural minority, or who speak a language that is different from the language spoken by the majority, are too often treated as if they suffer from some kind of deficit. Thus minority students are offered equity and access, but to take advantage of that offer, they can be expected to move away from their home languages (or cultures), and asked to engage with their education using an unfamiliar language. For students who are studying in mathematics classrooms in which more than half of the time they are unable to understand what is said by their teachers, the "access" provided is no access at all.

Instead, we would offer a more positive view of the potential gains brought to the table by minority language students who are learning mathematics or any other subject, whether with peers only or with majority students. We shall argue that these gains could be a direct consequence of either their cultural or language differences. Such students have the capacity to enrich the classrooms in which they study, provided their teachers are suitably prepared to take advantage of their presence and their cultural and language differences.

Mathematics Teachers and Teaching Mathematics

How do equity and access interact in relation to teaching? Arguably one element of access is the competence of the teacher in terms of both mathematical knowledge and preparation to function effectively in the classroom. Ill-prepared teachers, or those with inadequate background knowledge, are likely to undermine any claims of access or equity (cf. Akiba et al., 2007). Of course, similar concerns may be raised about the preparation of students on entering the school—their access to mathematics and their claims for equitable treatment may be influenced by the degree to which they are prepared to learn in terms of attitude and knowledge.

An issue that is not often framed at all is that of access of minorities into preparation as teachers of mathematics, and their retention once they do enter the profession. In the USA, the Business-Higher Education Forum (BHEF) (2007) documented a serious situation (emphases in original):

- The USA will need more than 280,000 new mathematics and science teachers by 2015.
- Shortages are most apparent in *high-minority and high-poverty classrooms,* where students are less likely to be taught by a teacher who is well-prepared in the subject area.
- In 2002, 72% of high-minority middle school mathematics classes were taught by teachers who had not majored or minored in mathematics, compared with 55% of low-minority classes.
- There is also a *critical shortage of minority teachers*, which is outpacing the overall mathematics and science teacher shortage.
- In 2003, 42% of public school students were from minority groups—yet only 16% of their teachers were minorities. (p. 1)

The last two bullet points draw attention to a significant problem. The usual factor mentioned in support of minorities as teachers is that the minority teacher is a role model for minority students. But diversity in teaching faculty teaches all students that diversity is to be valued in everyday society. In addition, the BHEF document provided evidence that in the USA there was a serious retention problem with an annual attrition of 394,000 teachers. The attrition rate of mathematics and science teachers led all other areas and was particularly high in schools regarded as high poverty. Other statistics in the BHEF list related to the impact of poverty thereby signalling the growing importance of this factor in equity and access, even though the BHEF document, in developing its recommendations, did not mention the need to deal with poverty.

From the above statistics, we better understand the possible explanation put forward by White et al. (2006), who stated that "college retention rates for under-represented minorities (URM) in science, technology, engineering, or mathematics (STEM) are lower than other groups. One reason may be that the studies often do not view premature departure from a cultural perspective" (p. 41). That is to say, although those conducting the studies reported the data, too often they did not take account of possible explanations based on ethnicity. This lapse contributes to the continuing problem of recruitment of minority teachers in these fields—if relatively fewer minorities take mathematics courses in college, the pool of potential minority teachers of mathematics will be correspondingly reduced.

The reader may wonder why it should be important for minorities to teach mathematics to minorities. Such a reader may subscribe to the mainstream position that mathematics is value-neutral, entirely objective and essentially the product of western thought, so that the ethnic background and the first language of the teacher should be irrelevant. In response to this mainstream view (which is a political position supported by those usually described as holding the utilitarian perspective described earlier), we raise again the very different picture of the place of mathematics that may be found in, for example, D'Ambrosio (1985), Mellin-Olsen (1987), and Powell and Frankenstein (1997). For these liberal scholars, mathematics is not merely a skill to be acquired in the service of a global society envisioned by the owners and managers of the dominating multi-national corporations. Mathematics is also a tool for the enlightenment of individuals and the transformation of societies. Many smaller societies are losing their cultures because of a continuing colonization that is supported at administrative levels in many of those societies by the insistence that all instruction should take place in, for example, the English language. An examination of prevalence of this scenario, including reports of relevant studies and the effects of the acceptance within some non-English speaking societies, will form a major part of the second half of this chapter.

We would claim that most students are taught by teachers who began their lives in a very different world from that of their students in terms of everyday access to technology. The exponential growth in worldwide forms of almost instantaneous communication combined with seemingly limitless access to information of all kinds has widened the gap between the current generation and the preceding ones from which the majority of teachers of today originated. Cheap cell phones that have taken on computer-like functions, including texting and email, Netbooks, and handheld tablets, are ubiquitous and not only in the developed world. Children beginning school in many parts of the world have always known the Internet. World Internet usage is measured according to a penetration index corresponding to the percentage of a population that uses the Internet (Miniwatts Marketing Group, 2011). Even in some African countries penetration exceeds 10% and in Europe, the USA, Asia and Australia the reported penetration is in excess of 30%. Given that students have always had access to more technology than their teachers, an important question for further research may be what assumptions and principles should be established both for mathematics teaching and learning, and for the preparation of teachers of mathematics, in order that students will be prepared, and able, to take advantage of technological advances.

That the third view of politics outlined earlier in the chapter as a set of practices that are intentionally devious and divisive is relevant to equity and access to mathematics education, is evidenced in the USA by the concerted attacks on teachers and teacher unions that have occurred for the last decade (see Maher, 2002). In 2011, these attacks reached a fever pitch with calls for "value-added" measures of teacher quality. The discussion typically opens with a position that few would argue against—that all students should have access to a competent and knowledgeable teacher of mathematics. Educational administrators argue that agreement with that point of view implies that there needs to be reliable ways of identifying and supporting teachers whose performance is less than competent.

In the USA a chain of reasoning has been developed that has growing appeal. That chain goes like this:

- Many students' test scores are unacceptable.
- Teachers are directly responsible for their students' individual scores.
- Therefore many teachers are ineffective.
- It is now possible through advanced technology to link each teacher with the test scores of each student that the teacher teaches.
- As students move from year to year it is possible to measure those students' changes in test scores from one teacher to the next.
- These change scores are statistically manipulated using different models to produce value-added measures (VAM).
- These measures are then attributed to the current teacher of each student.
- Averaging out the VAM for a class provides a measure of the effectiveness of the current teacher for that class for that year.
- Collecting VAM each year allows over time the identification of "good" and "bad" teachers.

Despite the rhetoric that of course such measures should not be the only measures, in the USA they are rapidly becoming the sole measure of teacher effectiveness and are often used as the sole criterion for teachers to retain their teaching positions.

Are there any problems with the VAM approach? First, many factors independent of the teacher contribute to what and how students learn. Second, the tests used are underestimates of student knowledge and they are also not appropriate for the sophisticated statistical models needed to create the VAM for each teacher. Complex models are necessary for a variety of reasons, for example, to allow for test differences from year to year and district to district. Indeed studies of various VAM approaches show wide variation in results on the same initial data, and in some cases it is possible to draw absurd inferences from their implementation. Now contrast the VAM perspective that rests solely on student results with that of Ingvarson and Rowe (2007), who pointed out the essential difficulty of conceptualizing and evaluating "teacher quality."

Are teachers alone responsible for the scores their students produce? The answer from many countries is a resounding "No." The model of learning that assigns all responsibility to teachers is the input model, which assumes that students sit passively while the teacher fills their brains with new knowledge—the test score is then assumed to provide a direct measure of the presence of that new knowledge. Very few educationists believe this is how students learn. Furthermore, almost no-one believes that standardized test data provide a direct measure, or even a good measure, of what students know.

Politicians and educational administrators universally preface any comments on test scores with the qualification that "test scores alone are not a good indicator of student performance." However, having said that, they then abandon their own caution and arrive at important decisions about the quality of teachers and students based solely on the test scores.

This whole process objectifies students; it reduces them to ciphers. It denies the reality that students make decisions to participate (or not participate); that students have a range of motivating factors that come into play in classroom situations, some conscious, some at the level of the subconscious.

There is nothing in the statistical models which takes into account factors external to the classroom; no matter how well-documented it is that these external factors strongly influence how well individuals learn. The principal external factor is *poverty*, which is not a student attribute but rather a debilitating condition of a student's existence. Consider these mathematics results from the National Assessment of Educational Progress (NAEP) in the USA:

> In 2009, about 49% of 8th-graders from high-poverty schools performed at or above *Basic*, 13% performed at or above *Proficient*, and 1% performed at *Advanced*. In contrast, about 87% of 8th-graders from low-poverty schools performed at or above *Basic*, 50% performed at or above *Proficient*, and 15% performed at *Advanced.* (Condition of Education: Special Analysis High-poverty Public Schools, 2010, para 1.)

Many of the designers of VAM are ambivalent in relation to the use of standardized test results for high-stakes decisions. Thus, for example, Steven Rivkin (2007) recognized the many difficulties with standardized test scores as the major source of data:

> The imprecision of tests as measures of achievement, failure of some examinations to measure differences throughout the skill distribution, and limited focus of the tests on a small number of subjects further complicate efforts to rank teachers and schools based on the quality of instruction. (p. 1.)

But in the very next paragraph, we read: "Yet despite these potential drawbacks, value-added analysis may still provide valuable information to use in personnel decisions and teacher compensation structures" (p. 1). Later, Rivkin noted that it was "unlikely that available variables account for all school and peer factors systematically related to both achievement and teacher quality" (p. 3). Still later: "The myriad factors that influence cognitive growth, the purposeful sorting of families and teachers into schools and classrooms, and the imperfections of tests as measures of knowledge complicate efforts to estimate teacher effects" (p. 5).

Although the drawbacks are real, and the information is suspect, teachers on the wrong end of personnel decisions can be dealt with harshly. Even following his enthusiastic support for VAM, Rivkin advocated important direct forms of teacher evaluation such as those practised at the school level, with well-prepared supervisors available to observe and provide relevant feedback aimed at supporting those teachers who need to improve.

The political aim of these attacks from political conservatives within the USA has been to lay the blame for "poor" US student performances in international and national standardized tests at the feet of teachers and teacher unions. That these attacks are unfair and based on misunderstandings about the interpretation of test scores, deliberate or otherwise, has been made clear by writers such as Bracey (2009), and Ravitch (2010). The effects on the morale of teachers are as yet unknown but most certainly are unlikely to be positive or neutral.

Some of the effects on the teachers' work practices, in the USA at least, are becoming apparent to those working with teachers in schools. An elementary school that the first author of this chapter visits regularly is a school with a majority of students of minority status, many of whom are classified as second-language learners. Now in a "restructuring" year, because of poor test performance on a state-wide standardized test, its students take the state tests for English and mathematics three times over the course of the school year. Only the best scores are counted. The pressure to meet yearly upgraded targets, which according to statisticians must eventually become unrealistic, has caused many schools to allocate ever-increasing periods of test preparation in mathematics and language. This extra time is almost exclusively directed at those students whose performances on the first opportunity to test are not quite "satisfactory" but are "approaching satisfactory." The colloquial expression for these children is the "bubble kids." The reader is left to speculate about the impact these changed practices are having on those students who are achieving at either high or at very low levels (as determined by their test performances).

Other areas, in which similar concerns have been expressed and rapidly followed by politically-motivated attacks, are the arrangements and requirements for teacher education and provisions for inservice education for teachers. Curiously the attacks often cite Finland as a place for the USA to emulate because of its successes in international tests. Never mentioned are three critical facts about teachers and teaching mathematics in Finland; the curriculum is determined at a local level, teachers are fully-unionized and almost all have the type of masters degree that is being attacked as inappropriate for US teachers (Kupiainen, Hautamäki, & Karjalainen, 2009).

International Cases of Colonization: "English First" in Teaching Mathematics

Mathematics does not consist solely of symbols, and it is concerned with more than manipulation and computation with numbers. Despite a commonly-held belief to the contrary, mathematics requires considerable language skills if it is to be well learned. Learning mathematics involves the development of concepts and the mastering of skills. Mathematical concepts are necessarily abstract and eventually come to be recorded with concision and precision. However to develop concepts successfully, most students need to engage in a great deal of spoken discourse with teachers and fellow students. Productive discourse is only possible when students engage in interchanges involving rich language to explain their individual perspectives. Mathematics also involves logical thinking, together with deductive and analytical reasoning.

Therefore to teach and learn well in mathematics, access to the language of instruction for both teacher *and* her students, is an important factor. Both the teachers and the students must be competent in the language of instruction if their discussions and explanations are to be understood by all parties. If the students are not familiar with the language of instruction clearly they will be deprived of access into higher levels of mathematics learning. This would seem to make obvious the necessity of the language of instruction matching the language spoken by the students. Furthermore, the teacher should have a deep knowledge of that same language. Otherwise, equity and access to mathematics learning will be compromised. This is not an issue in most developed countries where teachers and students by and large share a common language. Some developing countries in Africa (such as Kenya, Malawi) have changed their language policies over the past five years to ensure that their primary school pupils are taught in their mother tongue or home languages. This policy change has raised objections from some upper- and middle-class parents who believe that if their children were to be taught in English they would be more likely to gain access to the global world than if they continue to be taught in their home language.

Other countries have changed their language policy away from an emphasis on local languages first, presumably to suit political and economic agendas, and seemingly without knowledge of the potentially negative impact of an inappropriate choice of language of instruction on both equity and access into mathematical knowledge of the students within the country. English, which has rapidly become the dominant international language, is considered the language of power—fluency in its use is regarded more and more as a pre-requisite for gaining status and prestige, particularly for countries seeking to compete within the globalized economy.

Although English is a second or third language for the children of many countries (e.g., South Africa, Malaysia, Hong Kong, The Philippines, and American Sāmoa), in a number of such countries English is now required as the sole language of instruction for many school subjects including mathematics at all levels within the public school. In many places the "English-only" edict begins at the primary school and continues through all grades of the high school. The perceived political advantages of having confident English-speaking school graduates entering their workforce have trumped the local educational aims in many of the countries that have made this choice.

One wonders if sufficient thought has been given to the social and cultural impacts on the people of the non-English speaking nations that are making this choice, almost all of which are former European colonies. Below are several international cases seeking to illustrate the consequences of political action. Almost certainly, there are other cultures being marginalized with subsequent loss of their unique ways of thought through the insistence on the use of English-only in the schools and increasingly in the mainstream society. The irony is that this marginalization is being initiated and promulgated by influential members within each culture as those members seek to position their countries as players in the globalized society.

The Case of South Africa

Setati (2005) reminded us that "language is always political, not only at the macro level of policy making but also at the micro level of classroom interaction" (p. 450).

This is because the choice of language use and the purposes for its use are not only pedagogic but also serve the political purpose of developing a work force to enable the country to compete internationally. As a result, English is further advanced as *the* international language. It is also generally observed that in many formerly colonial countries such as South Africa, Nigeria, Malaysia, and others, a "change in the language policy of a country is often linked to change in political power" (Setati, 2005, p. 450).

Setati (2005) analyzed the language used in teaching and learning mathematics in a multilingual primary mathematics classroom in South Africa. The class was taught by a qualified and experienced African teacher who was competent in both English and the home language of her pupils (Setswana). Her analysis highlighted the dilemma and tension experienced by the mathematics teacher. On one hand, she was aware of the potential power of English as a gateway to access educational and other resources in South Africa, but on the other hand, she realized the importance of using her pupils' home language as the language of mathematics in conceptual discourse. However, insisting that the teacher and pupils used only English, far too often led to a parody of discourse as a consequence of which pupils came to memorize words and symbols without a complete understanding of their meanings. The negotiation of meaning that is one of the most important outcomes of genuine discourse was simply not possible in such circumstances.

More importantly, because English was imposed, pupils learned by inference that their home language could not be very important. So, unless a teacher was extraordinarily competent the only school discussions that the pupils experienced in mathematics classes would take place in a language in which pupils were only barely functional, and the cognitive content would be presented at a very low level only. Small wonder, then, that the pupils experienced "a devaluing of conceptual discourse as valuable mathematical knowledge" (Setati, 2005, p. 462).

In fact, a similar dilemma has been experienced by Malaysian mathematics teachers who have been operating under the policy of making students' non-home language the language of instruction for teaching mathematics and science in Malaysian schools (see Lim & Ellerton, 2009; Lim & Presmeg, 2011). Related issues will be discussed later in this chapter.

The Case of Botswana

In the case of Botswana, Garegae (2007) described problems faced by teachers and students that were similar to those in South Africa. In mathematics classes, it has been mandated that English will be the language of instruction. Garegae's (2007) study was very different from that reported by Setati (2005) above in that Garegae focussed on a more linguistic analysis of the language use in the classrooms in which mathematics was being taught. As the language of instruction, English was not the learners' first language, and teachers preferred to code-switch between English (L2) and Setswana (L1) even though this was not officially acceptable.

Garagae observed three junior secondary school teachers teaching mathematics and found that they used three types of code-switching: insertion, alternation, and sentence translation. Insertion referred to when "teachers inserted a word in a sentence expressed in another code; say a Setswana code inserted into an English sentence" (p. 235). Alternation refers to those situations where, "sentences are being alternated, and a complete sentence in one code is followed by another in a different code" (p. 235). The third type of code-switching, sentence translation, was found to be the most common and for this type, "the next sentence is the translation of what was expressed in the previous code" (p. 235). Garegae (2007) observed that the first two forms of code-switching encouraged a positional simplification strategy for acquiring L2 and thus disadvantaged the pupils. This was because when students heard isolated words regularly from the teachers, they were not able to learn the meaning of the word as well as the rules of syntax and grammar.

Garegae proposed that the translation of whole sentences from one code to another is a better type of code-switching because it helps to clarify the meanings of words, expressions and sentences expressed in another code through an entire reformulation of instructions. In Botswana's school mathematics curriculum, students were expected to be given a chance to experience a change in teaching methodology from the traditional method of transmission teaching strategy to more of a problem-solving approach, by which students were asked to conjecture and formulate hypotheses about a mathematical problem. Classroom discourse was encouraged whereby learners exchanged ideas, discussed and justified their arguments.

But for this to succeed, learners needed to be well versed in the language of teaching and learning. Therefore, Garegae (2007) argued, "if teachers code-switch without helping students to be able to construct proper sentences, then classroom discourse in Botswana schools will remain an unattainable dream" (p. 236). This case again highlighted the inequity in access to certain kinds of teaching approaches due to the lack of student competency in the language of instruction, with the root cause of inequity being the politically-mandated use of English as language of instruction.

The Case of Malaysia

Viewing English as the "language of power" in meeting the challenges of globalization, in 2003 the Malaysian Ministry of Education took a bold and drastic step implementing the new language policy of Teaching Mathematics and Science in English (or better known as PPSMI). According to Choong (2004), the initial rationale was "teaching the subjects in the science disciplines in English would expedite acquisition of scientific knowledge in order to develop a scientifically literate nation by the year 2020" (p. 2). However, English was not the first language of the majority of Malaysian teachers and students in schools. In fact, those teachers who were less than 45 years old had experienced their entire education (primary to secondary to tertiary) with languages other than English as the medium of instruction. Before 2003, English was taught as a subject, but not as the medium of instruction. Therefore, teaching mathematics in English posed great challenges, particularly to mathematics teachers in this age group—if their preparation in English was only as a stand-alone subject it was unlikely that they would have sufficient knowledge of English to conduct mathematics classes in English.

In one local study, Lim, Saleh, and Tang (2007) surveyed the perspectives of 20 primary school administrators, 443 mathematics and science teachers, and 787 primary Year 5 pupils from 20 schools in three northern states of Peninsular Malaysia, 5 years after the implementation of PPSMI. Their results showed that one-fifth of the teacher participants rated their own competency in spoken and written English as "poor." By comparison, almost all of these teachers rated their language competency in Malay and/or Mandarin as "good." Indeed, "if nearly one-fifth of the primary school teachers were incompetent in the English language, then their lack of confidence when teaching mathematics and science in English is entirely understandable" (Lim & Presmeg, 2011, p. 145).

After a review of the various related studies in Malaysia, Lim and Ellerton (2009) concluded that the overall confidence among mathematics teachers in their English language proficiency remained low enough for teaching in that language to appear as threatening. This lack of confidence might have led them to code-switch, or discouraged them from using English fully. For example, Tan, Lim, Chew, and Kor (2011) analyzed the discourse of 12 video-recorded mathematics lessons and found generally that the pattern of language use reflected the ethnicity of the pupils. Their discourse analysis showed that teachers talked more than their students, and that mathematics talk was much more common than non-mathematics talk. The use of English was greater than the use of mother tongues in all classes except the weak classes in the Chinese vernacular schools. In those schools the mother tongue dominated classroom discourse. However, the pupils' mother tongue was "the language to fall back on for the teaching of mathematics" (p. 141). The English language functioned more significantly in providing contextual discourse rather than conceptual discourse. Additionally, the pupils' mother tongue played "a major role as the language of conceptual discourse which required reflection and the articulation of one's reasoning" (p. 142).

Based on the data from the same study, Lim and Presmeg (2011) analyzed in depth the dilemma of teaching mathematics in two languages in one Malaysian Chinese primary school. Because of the complex socio-cultural demands of the Malaysian Chinese community, mathematics was taught in both Mandarin (the pupils' mother tongue) and English (the official language of instruction for mathematics) in this type of school. Both teachers in Lim and Presmeg's study emphasized that they resorted to code-switching so that those among their students who were weak in English would have a better chance of catching up with their peers. Consequently, a substantial amount of teaching time was wasted in making translations, especially of the terminology of mathematics. To expedite the teaching, these teachers sometimes opted to teach in the students' mother tongue (Mandarin) only. Hence, some of these students, particularly the weaker ones, may have been denied the opportunity to speak and express their mathematical thoughts in English.

Although the practices mentioned above were understandable from the points of view of teachers struggling to survive, they could well have created real learning problems for non-English speaking students. The source of these difficulties could lie in the decision at some administrative level to adopt a short-sighted political solution to what is a very complex educational problem. Malaysia will revert to requiring the mother-tongue to be the language of instruction in mathematics and science classes from year 2012 (Chapman, 2009). Inevitably, the debate concerning whether access and equity for some groups of pupils will be improved by the planned policy change will continue. We would maintain only that the issues of equity and access in learning mathematics are significantly related to the language of instruction for mathematics.

The Case of Aboriginal Australians in Homeland Communities

The example here is of a majority English-speaking nation with a small minority of Aboriginal people leading relatively traditional lives in remote communities now mostly in the far north and north-west of the country. Most Australia Aboriginal people have become urban dwellers and have adopted "white-fella" ways—but, as Harris (1991) reminded us, many still look to the remote groups leading traditional lives to maintain the cultural knowledge and languages of the Aboriginal people. Schooling in these communities was in theory conducted in English, but the common practice was best described in the words of an Aboriginal Australian colleague, "English is the language of instruction but *Yolngu Matha* is the language of explanation."

Two points were evident: first, the oral language was extremely and uniquely important so far as learning was concerned; and second, in *Yolngu Matha,* conceptions of space were expressed in ways that were completely unfamiliar in European languages—and hence, attempts at cross-translation mentioned earlier could not be successful. As Christie (1995) pointed out, political correctness in the 1970s "seemed to dictate that all languages are ultimately capable of communicating the meanings of all other languages" (p. 2). Christie also pointed out that languages express different epistemologies arising from different world views, and that it is likely that different mathematics is a real consequence of these different worldviews. This raised several points, not the least of which is the negative effect on Aboriginal languages and culture of being instructed in English. That, together with the added difficulty that many teachers are non-Aboriginal, and are non-native speakers of the local language, has created many very problematic scenarios.

How different are Aboriginal languages from English and other European languages? An emphasis on cardinal directions is one aspect that Aboriginal languages share with languages of other ancient cultures. English words "left" and "right" are not used, and there are not simple words for those concepts in the local language. Teaching children how to form letters in English provides an example of how different the languages can be—an English speaker might use up, down, left and right, but the

Aboriginal teacher would use the cardinal directions, north, south, west and east (in the local language) and the correct words in a situation would be relative to the child's spatial orientation.

The Case of American Sāmoa

Hunkin-Finau (2006) describes the situation in American Sāmoa thus:

> Although American Samoan society values the idea of bilingualism and biculturalism, its teachers are bound by an education system that promotes, and is heavily oriented towards, English and western values. Outside of their professional work, Samoan teachers live as Samoans in the community; inside the schools, they employ English and operate within a system that is tied to western values. (p. 49)

By adopting an English-only policy in the schools, there is loss of the traditional ceremonial forms of Samoan at the same time as there is growth of a form of Samoan contaminated by the kind of code-switching that Garegae reported in Botswana. The long-term result is that although Samoan students are losing their Samoan, they are not improving much in Standard English, and are certainly doing poorly in mathematics by most standards. A significant aspect of the problem is the limited knowledge of English of many teachers (Hunkin-Finau, 2006).

Concluding Remarks

Political decisions lead to policy formulation. A positive example of policy formulation that has had an impact on access and equity in mathematics for both students and teachers is that made, and implemented at the national government level, some 10 years ago, by Finland. Some believe that these decisions culminated in recent very strong international PISA performances by Finnish students (OECD, 2010a). Table 8.1 shows the major policy decisions taken in Finland on the right, which offer a strong contrast to the conventional model that is in effect in many countries, shown in the left column (Kupiainen et al., 2009, p. 12).

It could be argued that the key to Finnish success was the successful implementation of the outlined policies. This is to be contrasted with the unsuccessful implementation of the English-only education policy described in several cases earlier in this chapter. The usual reasons given by outside commentators for Finland's success are that it has a relatively small population, that the population is essentially homogeneous in terms of culture, with a high literacy level, and that Finland enjoys a low level of poverty among children. However two points should be made. First, 10 years previously, Finland, by its own admission, had an education system plagued with problems (Kupiainen et al., 2009), despite all the factors mentioned in the last paragraph that should have been associated with success. Second, the policies

Table 8.1
Comparison of Two Models of Policy Formulation

General Western Model	The Finnish System
Standardization Strict standards for schools, teachers and students to guarantee the quality of outcomes.	**Flexibility and diversity** School-based curriculum development, steering by information and support.
Emphasis on literacy and numeracy Basic skills in reading, writing, mathematics and science as prime targets of education reform.	**Emphasis on broad knowledge** Equal value to all aspects of individual growth and learning: personality, morality, creativity, knowledge and skills.
Consequential accountability Evaluation by inspection.	**Trust through professionalism** A culture of trust on teachers' and headmasters' professionalism in judging what is best for students and in reporting of progress.

adopted recognized and took advantage of the professionalism of teachers and administrators. The new policies removed many bureaucratic restrictions that are faced in education reform in most countries.

Perhaps at the heart of the politics and policy decisions taken within a nation, decisions that have an impact on equity and access in mathematics teaching and learning, is a general desire to develop the nation's political economy. Participation in the global marketplace is seen as very desirable as nations strive to improve the circumstances of their people. This essentially means that successful entry into the global marketplace becomes a major rationale behind many decisions, including educational, taken by the political leaders of a nation. Perceptions of success are related to producing an educated workforce. But this requirement demands a great deal of both teachers and students, particularly in countries where the political economy is unable to provide the necessary infrastructure and resources.

In such cases the implementation of the policies thought essential to joining the global market place, such as educating non-English speaking students in English only, falters and becomes counterproductive. Keady (2006) used the term "vulnerability" to remind leaders of nation states seeking to participate in the global economy that there are costs that go unrecognized associated with the supposed economic benefits. These costs include unwanted changes in social and cultural life within the state that may lead to a reduction in equity and access to mathematics learning, and indeed many other aspects of formal education.

It is impossible to close this chapter with a set of pronouncements concerning the overall situation with respect to the politics of access and equity to mathematics teaching and learning across the world. The level of complexity of such a task would be far too great. We have pointed to possible factors that make it less likely for some students to gain access to mathematics and to learn from a well-prepared teacher. Poverty remains a major factor—even in resource-rich developed countries there are pockets of citizens living below the poverty line. With few exceptions, hungry students do not learn as well, or as much, as others and are thus denied access and equity.

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