6

The Global Context

The country math education activity system links to the global activity system by playing the role of 'subject' in the latter. However, the hierarchical relationship between the two systems is not strong because it is not based on authority as is the case between the country and the school. This results in a socially loose activity system at the global level.

This chapter deals with inequities in math education at the global level. First, the activity system of mathematics education at the global level will be described and its factors and their attributes identified. Second, the inequities that result from the interactions of those factors and their attributes will be discussed in the light of relevant literature.

6.1 Math Education System at the Global Level: Factors and Their Attributes

A schematic diagram of the activity system of math education at the national level is presented in Figure 6.1. Each of the six nodes and its attributes are shown in a rectangle, with the name of the node in italics and its attributes as a list. The names of the factors (nodes) are the result of my interpretation of the factors of the activity system at the global level. The attributes that belong to each of the six nodes of the activity system are derived by logical analysis based on their relevance to equity.

The activity system of math education at the global level differs from both the school and national systems in many respects as can be inferred from the the factors and their attributes in Figure 6.1. In the next paragraphs, the factors and their attributes will be described and exemplified.

6.1.1 Math Education

The object of the activity system at the global level is engagement in math education by the math education communities of different countries in two

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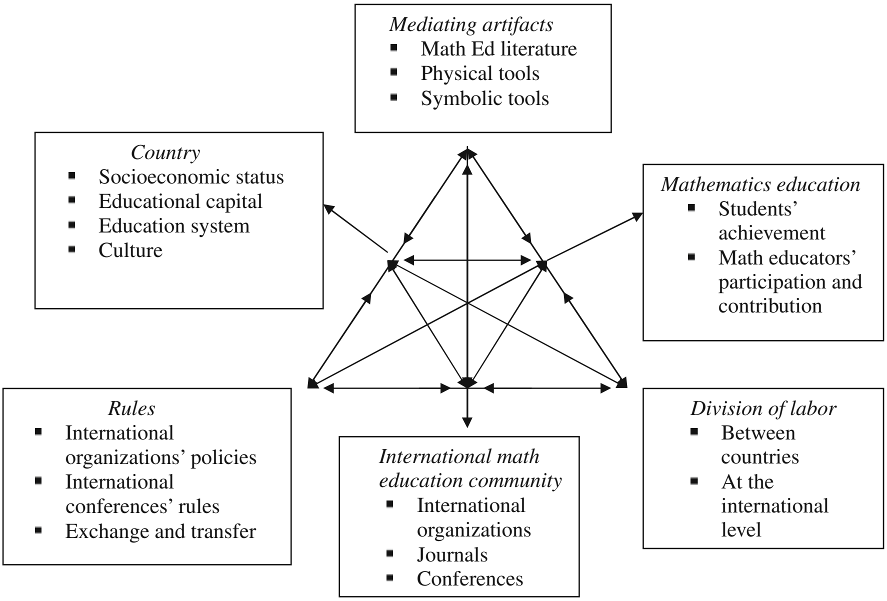

Fig. 6.1. Factors and their attributes in the activity system of mathematics education at the global level

related activities: Math learning and math education research. The countries' *achievement* of the desirable math learning outcomes constitutes the outcome of teaching and learning mathematics. On the other hand, the *participation* of math education communities in generating knowledge about math education is the outcome of engagement in research in math education.

6.1.2 Country

Research has shown that some of a country's attributes are critical for education in general, and for math education in particular. One significant attribute is the *country's socioeconomic status*, which represents the country's wealth and the way it is distributed among the population. The Gross Domestic Product (GDP) and the Gross National Index (GNI) are the best known measures of economic status for a country. Several social indicators are also used, such as Gender Parity Index. Another attribute is the *country's education capital* defined in terms of the spread of basic education as measured by the adult literacy rate as well as the level of education in the country as measured by enrollment rates at the secondary and tertiary levels. The nature of a *country's education system*, being closely related to its political system and its history, is a third attribute. Last, but not least, the *country's culture* is reflected in the ideological, social, and technological aspects of society and these impact math education. The identity of the country's mathematics education community is not only shaped by these factors but also by their interaction. For example, a country in which socioeconomic divisions coincide with cultural divisions in society would be different from one whose socioeconomic and cultural divisions do not coincide.

6.1.3 The Math Mediating Artifacts

The math mediating artifacts consist of symbolic and physical tools used by the country's education community in the teaching and learning of mathematics as well as research tools in mathematics education. The mediating tools used in the teaching and learning of mathematics were mentioned in earlier chapters and include symbolic tools such as the natural language, the language of mathematics, and physical tools such as textbooks and computers. Math education constructs, the accumulated math education literature, and ICT technologies such as the internet, are the essential tools for conducting research in math education.

6.1.4 The International Math Education Community

In principle, the international math education community consist of math educators and researchers in all countries. Compared to school and national communities, the international community has limited means for interaction. Math education international organizations, journals and conferences are the most important venues for interaction within the international community.

6.1.5 Division of Labor

Division of labor at the international level includes the division of responsibilities and power among the international math education community. The division of labor takes the form of regional cooperation in order to further math education and research in the countries of the region. Division of labor at the international level is normally done by the international organizations, which set up policies and mechanisms for assigning the responsibilities of planning and executing international activities among the different countries.

6.1.6 Rules

The rules that govern the relationships between a country's math education community and the international math education community are the policies set by the international math education organizations, editorial boards of journals, and conferences' organizing bodies. However, there are other implicit and undeclared rules stemming from rules based on political and economic power considerations.

6.2 Interactions and Inequities: An Example

The factors and their attributes are, in principle, neutral by themselves as far as equity or inequity are concerned. Inequities are generated as a result of interaction of these factors and their attributes. The interactions of such factors will be called *inequity factors*.

Using a hypothetical example, we illustrate how the interactions of the factors and their attributes generate inequities in the international activity system. Consider the math education communities in two countries, one being a developing country (low socioeconomic status) and the other a developed country (high socioeconomic status). It is likely that the math education community in the developing country does not have as much access or ownership of internet or knowledge of English as in the developed country. This by itself might generate an inequity between the two countries in terms of ownership of two mediating artifacts basic to math education. This will generate a chain reaction which results in inequitable participation of the two countries in math education at the international level. For example, because of their limited English proficiency and access to internet, the math education researchers in the developing country are at a disadvantage in communicating with the international community. Even if a math educator in the developing country succeeds in submitting a proposal to an international conference, it may not be accepted on the basis of inadequate 'quality' or questionable 'relevance' to the international community. If against all odds, a submission is accepted, its author will not have the financial resources to travel in order to participate in the conference. Obviously, this interaction of a country's socioeconomic status with the mediating artifacts (English and math education literature) may eventually lead to its exclusion from participating in math education at the international level.

The chapter will be organized under the following titles:

1. Inequities Related to Country, Community, and Division of Labor Interactions
2. Inequities Related to the Interaction of Country and Mathematics Learning
3. Inequities Related to the Interaction of International Policies and Participation

6.3 Inequities Related to Country, Community, and Division of Labor Interactions

The inequities in mathematics education at the global level may result from complex interactions among the triad consisting of country, international mathematics education community, and the division of labor. Many of the inequities in mathematics education among countries may be accounted for in terms of the country's socioeconomic economic status and culture which are likely to impact the educational capital in the country in terms of the spread and level of education in it. In general, a country with high socioeconomic level is likely to have more educational capital, and better resources for math instruction, than does a country of lower socioeconomic level. The country's socioeconomic status is critical in availing funds for research and travel, thus affecting mathematics education research productivity, which in turn, affects the country's participation in international conferences and contribution to international research journals. The country's culture also affects its participation in international mathematics education. As the English language has become the language of international conferences and journals, lack of competency in that language prevents math education researchers from participating in such conferences or publishing in such journals.

The division of labor in mathematics education among countries is determined, to a large extent, by the country's clout in research productivity. Needless to say that the less developed countries are at a disadvantage in this respect and this may lead to their partial or total exclusion from involvement in organizing international activities. These considerations give rise to a two-tier system of mathematics education at the global level: The upper tier, which we call the *optimal mode of development* in mathematics, consisting of the developed countries who participate actively in the international mathematics education community and the lower tier, which we call the *separate mode of development* consisting of the the marginalized countries who shy away from engaging actively in international activities in mathematics education.

In the last half of the past century, the decline of colonization was a major reason for the two-tiered system of mathematics education. During the age of colonization, the two-tier system did not exist because colonized countries, mostly developing countries, adopted the mathematics education of the colonial rulers. However, as colonization started to be dismantled, the developing countries, had to invest most of their resources in providing public education to increasing numbers of students. This was often done at the expense of the quality of education and of educational research and development. Hence most of the developing countries did not have the chance to accumulate enough 'credentials' in mathematics education to fully participate in the international mathematics education community.

6.4 Inequities Related to the Interaction of Country and Mathematics Learning

International comparative studies consistently indicate that the country's socioeconomic status correlates positively with the average national math achievement score. In TIMSS, for example, all developed countries are at about or above the international average in mathematics achievement while the developing countries are mostly below the international average. In Chapter 11, a set of measures of socioeconomic indicators are correlated with the national average mathematics score in TIMSS 2003. Among a number of economic indices, the Gross Domestic Product (GDP) and the Gross National Index (GNI) per capita were the two variables that correlated positively with the national mathematics achievement score. The impact on mathematics achievement, as measured by the percentage of variance in mathematics achievement accounted for, was 14% for GDP and 19% for GNI. The Poverty Rate (PR) correlated negatively with mathematics achievement and it accounted for 27% of the variance in mathematics achievement. All in all, the higher the income per capita in a country the higher the mathematics achievement and conversely the higher the PR in a country the lower the mathematics achievement.

Also in Chapter 11, the relationship between the educational capital in a country and its mathematics achievement score in TIMSS 2003 is studied. The educational capital of a country depends on the literacy rate and enrolment rate beyond basic education. Tertiary enrolment rate accounted for 37% of the variance in mathematics achievement, and adult literacy accounts for 40% of the variance in mathematics achievement.

Accounting for mathematics achievement differences among countries in terms of cultural differences is too complex to analyze. Stevenson, Lee, and Stigler (1986) pioneered studies which attempted to account for mathematics and reading achievement differences among American, Japanese and Chinese children, not only in terms of educational input but also in terms of cultural differences. The authors concluded that the cognitive abilities of the children in the three countries were similar, but large differences existed in the children's life in school (for example time spent on academic activities), the attitudes and beliefs of their mothers (the belief regarding the relative importance of the child's ability or effort in success at school), and the involvement of parents and children in school work. The authors implied an association between the lag in mathematics achievement of American children, in comparison to Japanese and Chinese children, and the differences in cultural practices and beliefs in the three countries. The much debated 'learning gap' between the USA and other developed countries, as reflected in TIMSS studies, led to the question, much debated in the USA, whether educational policies and practices can overcome cultural effects. Stigler and Hiebert (1999) addressed this question in their book *The Teaching Gap* arguing that, while it is impossible to change the culture of the the society as a whole, it is possible to change the classroom culture by making use of the best ideas from the world's teachers.

Language is a factor that may affect mathematics achievement differentially, at least in comparative international studies. The tests used in such studies are translated to the language of the country; however, much is lost, and much cultural load is carried, in such translations. Another cultural factor which may have a differential impact on between-countries mathematics achievement is the over inculcation of ideologies. The effect of this ideological factor on mathematics education is two-fold: First, such ideologies are normally taught through rote learning methods which transfer to the teaching of mathematics, and second, the instructional time given to such valued ideologies, being commensurate with its value to the society, may take away from the instructional time allotted to mathematics in the curriculum (Jurdak, 1989).

6.5 Inequities Related to the Interaction of International Policies and Participation

The interaction of international policies and regulations impacts mostly the relationship of the country with the international mathematics community and with the division of labor among the different countries. This interaction produces inequitable participation of countries in the international mathematics education community.

6.5.1 International Policies

Policies, which govern the international mathematics education institutions may result in inequities in the countries' representation on the policy-making bodies as well as their participation in international activities. As an example, we consider the International Commission on Mathematics Instruction (ICMI), which is the mother of all math education organizations and which sponsors the International Congress on Mathematics Education (ICME). ICMI is under the umbrella of the International Mathematics Union (IMU), whose membership (70 out of 195 countries in 2008) constitutes that of ICMI; the latter, however, can co-opt other member states upon the approval of the IMU executive committee (see IMU at(www.mathunion.org) and ICMI at(www.mathunion.org/ICMI)). At present ICMI, the highest international mathematics education organization, has only 72 countries represented which is less than 40% of the number of existing countries. The reason for this is that the basis for membership in IMU, and consequently membership in ICMI, *depends on the number of publications of the country in mathematics.* Most of the developing countries do not meet the criterion to join IMU and consequently ICMI. This means that countries that do not meet the criterion to join IMU lose their opportunity to join ICMI's membership, simply because they are not active in mathematics research, in spite of the fact that they may be very active in mathematics education.

The obstacles that face math educators from developing countries when attempting to participate in international conferences are many and varied. Some of those obstacles relate to the policies and practices of the organizing bodies of these conferences and some to the countries themselves. Normally, international conferences are organized in developed countries in cities that have the infrastructure and specialized human resources to support such large conferences. For math educators of developing countries, the cost of attending such conferences can be daunting, as there are neither resources nor traditions in their country to support their participation. However, there is increasing awareness on the part of the international mathematics education organizations of the need to alleviate some of the financial burden on mathematics educators from developing countries to enable more of them to participate in international conferences. There is also an effort to provide assistance in editing the English of their contributions.

Another policy which puts some math educators at a disadvantage with regard to their participation in international conferences is the adoption of English as the language of such conferences. Moreover the call for these conferences is usually done through emailing lists which, in most cases, are based on previous participation. Furthermore, the policies that govern acceptance of contributions do not have enough flexibility to allow a wide range of diverse profiles in content and format, though such contributions may be perceived as meaningful in the contexts of the authors' countries.

The same can be said about international journals of mathematics education. The publication policies of such journals are almost standardized along Western scientific journals and consequently exclude contributions that address local issues perceived by their authors as meaningful in both the local and the international contexts. Because of the stringent standards in refereed journals, the English language is more of a barrier in international math education journals than it is in conferences.

6.5.2 Exchange and Transfer

Exchange of mathematics education research and experiences is one way for countries to learn from one another and consequently to bridge any gap in their mathematics education development. ICMI has sponsored many regional conferences for that purpose in different regions of all continents such as:

- ICMI East Asia Regional Conferences on Mathematics Education
- Espace mathematique
- All-Russian Conference on Mathematical Education
- Inter-American Conferences on Mathematics Education
- First Africa Regional Conference

Another form of one-way exchange is the transfer of the mathematics education experiences of one country to another. One motivation for such transfer is that some developing countries look up to more influential countries because the latter are perceived to be superior politically, economically, or educationally. The transfer of USA NCTM Standards to many countries is an example of such extensive transfer. Recently, curricula and textbooks of countries which consistently ranked highly in international assessment studies, like Singapore, started to be transferred to other countries, such as the USA. However, if not adapted to the cultural and social conditions of the receiving country, the transfer of mathematics education from one country to another may result in possible exclusionary practices of some social or cultural groups.

6.6 Concluding Remarks

The inequities in mathematics education at the global level are the result of complex interactions among the triad consisting of country, international mathematics education community, and the division of labor. The defining attributes of these factors seem to be the country's socioeconomic status and its culture which determine to a large extent, the country's educational capital and help shape the country's education system in terms of governance and resources for mathematics instruction.

The inequities that were generated by the interactions among factors and attributes of the system, helped create a two-tiered system of mathematics education at the global level. The upper tier, which we called *the optimal mode of development* includes the developed countries integrated in the international mathematics education community. The lower tier, which we called *the separate mode of development* consists of the marginalized countries that have yet to be integrated in the international activities in mathematics education.

The country's socioeconomic status as well as its culture have a differential effect on mathematics achievement. Data from international assessment studies indicate that the higher the income per capita in a country the higher the mathematics achievement. On the other hand, the higher the poverty rate in a country the lower the mathematics achievement. Some authors attempted to explain differences in mathematics achievement among countries in terms of between-country cultural differences, which led mathematics educators to focus on closing the learning gap through addressing the teaching gap. They recommended capitalizing on the best international teaching practices to optimize learning.

The rules that govern the functioning of the international mathematics education community produce inequities in mathematics education. These inequities are reflected in the extent to which mathematics educators participate and contribute to international conferences and journals as well as the extent to which countries are represented in international mathematics education organizations. It seems that inequities among developing and developed countries exist in both participation and representation in the international mathematics education community.

Perhaps it is easier to deal with inequities at the global level than at the school or national levels because the former is an ad hoc socially loose system that is free of national bureaucracies. The transformation of the global system may be achieved through a three-prong strategy based on Engeström model of expansive transformation (1999):

Reflection at the country level: The country's math education community identifies and reflects on the obstacles that face it in being integrated into the international math education community.

Addressing inequities at the country level: The country's national community starts to address the sources of inequities at the country level. This can take many forms depending on the country's system.

Transformation of the international system: The international organizations of math education come up with necessary policy and organizational changes in order to allow for participation of more developing countries.