IV. ASPECTS OF THE STUDY

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Textbooks give more information about intended practices as well as about the roles of the teacher and the students but other teaching materials are also revealing. Videotapes of classrooms are increasingly being used as research data in cross-cultural research studies. Aspects of student achievement are well used in comparative studies, but can give misleading and shallow information if not adequately interpreted through deeper cultural and social perspectives. Data on students' and teachers' attitudes, beliefs and values will be particularly interesting for this study as these often reveal more about the significant aspects of difference between cultural traditions.

III.5 Different perspectives on mathematics

Differences in mathematics education intentions and practices are often stimulated by the different influences coming from various groups of professional working in and with the area of mathematics education. In addition different cultural traditions view mathematics itself in different ways, as has already been pointed out in an earlier section.

In this study therefore the IPC wishes to seek contributions from people who work in different parts of the mathematics education community. In a rich comparative study such as this, different perspectives are crucial, and colleagues who work in areas such as mathematical applications, informatics, and the history and philosophy of mathematics are encouraged to participate.

III.6 Different perspectives on the study of mathematics education

In the same sense as in the previous point, there are several different approaches to the study of mathematics education which need to be recognised in this study. Although the IPC sees case studies as being important kinds of contributions, it also does not seek to restrict the methodology of the studies presented. It recognises value for example in psychological, sociological, and anthropological approaches as well as in contributions from other areas of the educational sciences.

The IPC is also aware that as this comparative study develops, particular differences in methodology between cultural traditions may become revealed, for example concerning the position and role of researchers. It is conscious of the dangers of applying certain methodologies from one cultural tradition inappropriately in another cultural tradition. The IPC therefore hopes that one outcome of this study is an increased awareness in the international mathematics education community of the need for cultural sensitivity in carrying out future comparative studies.

IV. ASPECTS OF THE STUDY

IV.1 Context

Mathematics education does not take place in a vacuum, but there is always a host of different contexts within which the practice of mathematics education takes place. These contexts may be social, political, economic, philosophical or ethical, but they are of course all related one way or another to the underlying cultural values. What are the elements within these contexts which are relevant to mathematics education? What are the 'givens' from which we organize our mathematics education, and what are the constraints within which we carry out the education?

IV.2 Determinants of the curriculum

In the literature on sociology of education, an important characterisation of an education system is to identify the significant figures or interested parties that determine education policy in general and the curriculum in particular. In this study, however, we are interested not in these general sociological issues, but in the determinants of the mathematics curriculum. Who are the major players (e.g. mathematicians, mathematics educators, school teachers, bureaucrats etc.) in determining a particular mathematics curriculum ? Are there significant cultural differences in the constellation of determinants of the mathematics curriculum ? In addition to the issue of 'who', we are also interested in the mechanism through which the mathematics curriculum is determined. Are there cultural differences on how the mathematics curriculum is determined (e.g. centralized versus decentralized) ?

IV.3 The role and place of mathematics in the overall curriculum

Mathematics occupies a central place in the curriculum of nearly all countries in the world, yet there may be subtle differences in the importance attached to mathematics as a school subject in different countries or cultures. As far as the education system is concerned, what role is mathematics playing in terms of sifting or filtering students through the education ladder in different countries ? Is mathematics a highly aspired subject ? What place does mathematics occupy within the overall curriculum (this may be reflected, for example, in the number of hours devoted to mathematics) ? Is mathematics viewed as a service or instrumental subject, a subject for mental training, or a subject essential for the development of a cultured citizen ? The different perceived roles of mathematics may affect the way mathematics education is conceived and organized in different countries and cultures. These are related to points (6) and (11) below.

IV.4 Teachers, teacher education, values and beliefs

The teacher is one of the most crucial elements in the implementation of the mathematics curriculum, and hence a study of mathematics education in different traditions should definitely focus on the teacher. Are there cultural differences on the image or role of teachers in the education process ? Are there differences in the way mathematics teachers are educated or expected to be educated ? What are the relative emphases on the subject matter (mathematics), pedagogy, and pedagogical content knowledge in the teacher education curriculum ?

The literature shows that there is a high correlation between the attitudes and beliefs of teachers on the one hand, and their instructional practices on the other, and it will be both important and interesting to see whether there are cultural differences in teacher attitudes and beliefs. For example, how do teachers in different cultures perceive the nature of mathematical knowledge ? The literature shows that mathematics is viewed by teachers as more or less a subject of absolute truth or as a fallible subject. Are there any cultural differences in these attitudes ? Also, are there cultural differences in the patterns of attribution of success and failure in mathematics ? Does the strength of the relationship between attitudes and practices differ in different cultures ?

IV.5 STUDENTS, LEARNING STYLES, ATTITUDES, ROLE OF STUDENTS IN THE TEACHING/LEARNING PROCESS

Just as teachers in different cultures differ in their attitudes towards mathematics and mathematics teaching and learning, students in different cultures are reported to differ in their attitudes towards mathematics and mathematics learning. Do these differences in attitudes lead to differences in learning styles ? For example, are Asian students more passive in mathematics lessons ? Does physical passivity necessarily imply mental passivity ? Can we account for the different achievements of students by differences in attitudes and learning styles ?

Also, does the pattern of gender differences in attitudes differ in different cultures ? Are boys and girls treated differently in different cultures ? How are students of different abilities (e.g. gifted children, disadvantaged students) treated in different cultures ? Is the role of student in the teaching and learning process perceived differently in different cultures ? These differences, if they exist, will definitely affect both the way teachers organize their teaching as well as the way students participate in the teaching and learning activities.

IV.6 INTENTIONS AND GOALS

Studies of different cultural traditions often reveal differences in the goals of education, and it is likely that there are also important differences in the goals and aims for mathematics education. This does not just concern the formal and published goals and aims in, for example, government publications, but concerns also the informal, understood but not stated intentions which people from a cultural tradition take as natural, assumed, and unimportant to discuss. So, are there formally described differences in the goals and aims of mathematics education between different cultural traditions, and what are they ?

Intentions however are more general phenomena than goals and aims, and concern personal values as well as societal expectations. In this study it is hoped to reveal more of the informal intentions that the different cultural traditions hold for mathematics education as well as the more formal goals. Is it possible through this study to identify these informal intentions and to explore the systematic differences between them ?

IV.7 CONTENT

The differences between the content taught in various countries would appear to be important in this study, particularly in explaining variation in student's performance. School mathematics syllabuses might ostensibly be similar in different societies, but the arrangement of the content and the approach to particular topics could be very different. For example, the content of geometry taught in school might have different emphases on coordinate geometry, vector geometry, Euclidean geometry, transformation geometry or indeed on the integration of these geometries in different countries. Whether algebra is or is not considered as a means for mathematical argument can result in very different approaches to algebra.

So, the question is, how do the different aspects of content chosen and the approaches taken interact with, and how are they influenced by, particular cultural values ?

School mathematics is developing. For example, the modelling of situations through programming and computer algorithms has developed a certain appropriate content for

school mathematics, such as testing the correctness of algorithms. How do different cultural traditions react to such new content ?

Comparison of content can also focus on some specific issues. For example, how are ideas of proving and testing in mathematics introduced and developed ? How is discrete mathematics implemented in school ? What has been the legacy of the New Math that was exported from the West to many countries in the 50s ? Such issues may also have significant cultural roots.

IV.8 Methodology and media

Methodology of teaching and learning is one of the master keys opening up differences in mathematics education, both in theory and practice. Researchers have shown rising interest in comparisons in different countries for the last two decades and they generally agree that differences are both substantial and striking.

Major and coherent questions are :

1) What are the real differences of teaching and learning in the classroom ?

2) Why are there differences ?

3) How can studies of differences help us to improve teaching and learning ?

Section II.3 has already been dealing with question 3) and we will not go into any more details here.

As to question 1) differences have been observed and studied in many aspects like classroom organisation and routines, teaching sequences, instructional expectations from students, teacher-student interactions, representations for mathematical concepts and procedures. Are these the most influential aspects of differences and which others should be considered ? For example, what about the process of planning, analysing and evaluating lessons ? Or a deeper insight into the changing teacher-student interaction influenced by general changes in the attitudes of different generations towards each other and the growing interaction of students with each other about learning and with informal teaching and learning resources, such as the internet ?

There have been attempts by researchers to characterise differences in mathematics lessons in Japan (e.g. as built around a consideration of multiple approaches to carefully chosen practical examples or activities). In lessons in American schools some researchers see teachers presenting information and directing student activities and exercises with a unique feature of the multiplicity and diversity of both topics and activities.

How can these issues be investigated further and understood more deeply ?

As to question 2) reasons for differences observed have been found in different theories about teaching and learning. Education in general and teaching methods in particular do rely on very different fundamentals e.g. philosophy-oriented, science-oriented or application-oriented (or dialectical, hermeneutical, empirical-analytical). Schemes for the structuring of a lesson also can follow a dialectically oriented model of the process of education (*Bildung*), a process of development as in nature or technology, or a model oriented at the problems to be handled.

Theories about learning are often related to psychological considerations, resulting in a behaviourist or action-oriented view, e.g. which concepts are dominating in different traditions and what are the consequences, good and bad ?

In practice, teaching and learning is strongly dependent on the formal organisation of lessons and strings of lessons, following principles like education (*Bildung*) oriented, subject matter oriented or student oriented for the structuring of lessons. So to answer

the question why there are differences we have to find out in detail about a mixture of philosophical, social, psychological, cultural, political, economical and even ecological intentions and principles for teaching and learning.

Strong changes in teachers' and students' activities in class are reported from many countries. Control of teachers on the activities of students is diminishing. Students rely on outside sources or on information from their peers. They become more active in class and they want to have influence on contents and goals. Models like 'students teach students' or 'learning by teaching' are practised. How do mathematics educators in different traditions judge these activities? How do they try to exploit them for mathematics education purposes or how do they try to avoid them happening?

Some of the observations just mentioned originate from the new role of the didactic component 'media'. Compared to classical media like blackboard and chalk or the OHP, modern information technology based media like multimedia computers have a stronger touch of educational intelligence. They can furnish students with information as well as with some advice for learning and about correctness of findings. Communication technology can open up the classroom for geographically and — this is more important — culturally distant information, giving rise to activities like 'distance learning'. These experiences have a very strong impact not only on cognitive but also on emotional intentions in class (motivation, creativity, ambition). Our study will not only have to evaluate the quality of these attempts but also compare reactions to this kind of challenge in different traditions.

Do we see modern media as a new component in the conservative teacher-student structure of the classroom? What chances and what risks do we see in the new media and what are we doing about it? How can we explain the unchanged importance of teachers for the learning process to society, and how the new role? Even if we see the risks of the new media, can we avoid them? Many societies have seen a 'metacognitive shift' going on at all levels of information and communication processes. There is less interest in the contents of these processes and growing interest in the medium carrying the contents. How do we uphold the intentions of mathematics education as far as contents and methods are concerned?

IV.9 Assessment of students' achievement

There have been different views and approaches to the assessment of students' achievement in mathematics. For example, in East Asian societies, students, teachers, and parents view written tests and examinations as one of the most important things in a student's school life and as a key to the success of their future life. There are also high-stakes college entrance examinations. This does not seem to be the case in many Western societies. Moreover, there have been great differences in the approaches to assessment of students' achievement in different societies with different traditions. For example, in Western countries (e.g. the United States), standardized tests and multiple choice questions have been used for a long time in the assessment of students' achievement. Recently, alternative assessment methods have been increasingly used in Western schools. Again, this is not the case in Asian countries, though we can see some influence of the standardized test and alternative assessment in some Asian educational systems. The question is, what are the exact differences in assessment of students' achievement in different societies with different traditions? Why are there such differences? Will there eventually be a universal view and approach to the assessment of students' achievement because of the growth of globalization and information technology?

IV.10 Different aspects of achievement

Many available comparative studies, especially large-scale achievement assessments, have shown that East Asian students overall outperform their Western counterparts in mathematics. However, some recent researches have suggested that the superior performance of East Asian students is more evident in certain aspects of mathematics achievement, such as using basic skills of computation and algebraic manipulation, solving routine problems and school mathematics problems by applying algorithms, and it is less so in some other aspects. In some studies, researchers found that Western students performed as well as, or sometimes even better than, their Asian counterparts in aspects such as using visual and graphical representation and solving open-ended problems.

Some people have also argued that East Asian students might be better at abstract thinking in mathematics, but Western students might be better at intuitive thinking. Is this really true ? In other words, do Asian students perform better in some aspects of mathematics achievement, and worse in some other aspects than Western students ? If so, do the differences in these different aspects of achievement reveal certain differences in cultural traditions ?

Furthermore, it has been shown in some international studies that students in East Asia, such as in Japan, do not like mathematics as much as, but they performed academically better than, students in Western countries. The question is, to what extent are students' attitudes towards mathematics and mathematics learning affected by their cultural traditions, by their social environment, or by their school learning experiences ?

IV.11 Views on the nature of mathematics

Researchers have documented the fact that different kinds of mathematics have developed through different cultural traditions. For example, there are significant differences between ancient Chinese mathematics and ancient Greek mathematics. The former is more algorithm-oriented and application-oriented, and the latter is more oriented towards deductive reasoning and not towards the application of mathematics.

The question then is, how do different cultural perspectives on the nature of mathematics influence mathematics education in different traditions ? Moreover, what is the relationship between the cultural traditions and the societal views on mathematics and mathematics education in different traditions. In other words, how do they influence or interact with each other ?

IV.12 Uses, misuses, and abuses of mathematics

There are different views on the relationship between mathematics and society. It has been claimed that mathematics is essential to a modern society, and mathematics can help people become informed citizens and make wise decisions in their individual and social life. This seems particularly true in the modern information age. However, it is not uncommon to see that mathematics, including statistics, is misused or even abused intentionally or unintentionally on different occasions and for different purposes. The question in this connection is, how is mathematics used, misused, and abused in different societies with different traditions ? Why is mathematics used, misused, and abused in this way or that way in different societies ? What can we do in mathematics education to help students as well as the general public to understand mathematics and its usefulness appropriately so they will not mathematically mislead others or be

misled by others with numbers, data, graphs, statistics, or other forms of mathematical information.

IV.13 Non-formal mathematics education

In addition to formal school mathematics education, there are other forms of mathematics education, e.g., Juku schools in Japan, Bu-Xi-Ban in Hong Kong and Taiwan, private tuition in Singapore, mathematics clubs within schools, internet-based and home-based learning, to name a few. In this regard, we are interested in the following questions: what are the other forms of mathematics education existing in different societies with different traditions? Why do they exist in different societies? What role do they play in the whole picture of mathematics education? How do they interact with formal mathematics education?

IV.14 Evolution of mathematics education

Mathematics education has a long history in human civilization. The question of interest is, how has mathematics education been developing and changing in different countries or societies in different traditions? As the world is increasingly globalised and information technology helps people in different places communicate and share their questions, ideas, and information more freely and conveniently, will there be a universal approach to mathematics education? What can we learn about mathematics education from the past in order to ensure a better future for mathematics education?

V. CONTRIBUTIONS TO THE STUDY

V.1 Call for contributions

The ICMI Study *Mathematics education in different cultural traditions: A comparative study of East Asia and the West* consists of

- an *Electronic Discussion Forum*,
- an invited *Study Conference*, and
- a *Publication*, to appear in the ICMI Study series.

A discussion web-site is being set up, and members of the mathematics education community are invited to participate in discussion on the major topics and problems identified in this discussion document or related issues. Please refer to the official web-site at the end of this document.

The invited Study Conference, with a size of about 80 to 100 participants and a duration of 5 days, is scheduled for October 2002, in Hong Kong.

The IPC, as well as ICMI, is interested to have approximately equal number of participants from East Asia and the West, like the composition of the IPC. English, however, will be the language of the conference. We are well aware that this may mean a handicap for many individuals whose first language is not English, but we would nevertheless like to encourage such people to participate. We would also like to encourage the native English speakers to take special care of this situation. We will have little chance to succeed in a real comparative study if we do not succeed in managing the language problem in the Study Conference.