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ABSTRACT

This paper reports on an attempt to formulate an East Asian theory of mathematics education. Six features of East Asian mathematics education are discussed and contrasted with features and values in Western education. These factors include product versus process, rote learning versus meaningful learning, extrinsic versus intrinsic motivation, and subject matter knowledge versus pedagogical knowledge in teachers. The impact of modern technology on the teaching of mathematics is also discussed. (Contains 29 references.) (MM)

In Search of an East Asian Identity in Mathematics Education - the Legacy of an Old Culture and the Impact of Modern Technology[1]

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Introduction

East Asian students have consistently outperformed their counterparts in Western countries in recent international studies of mathematics achievement (Robitaille 1989; Stevenson *et al*, 1990, 1993; Lapointe et al, 1992; Beaton *et al*, 1996; Mullis *et al*, 1997; Wong, 1998). Given this superior performance of their students, one must have expected the East Asian countries[2] to have a superior mathematics education. But a review of the literature on the East Asian mathematics classroom does not seem to concur with this expectation.

From the relevant literature, it is found that the curricula in these East Asian countries are content oriented and examination driven. Teaching is very traditional and old fashioned. Teachers in these countries seem to be ignorant about the latest methods of teaching, and think that mere competence in mathematics is sufficient for effective teaching of the subject. Classroom teaching is conducted in a whole class setting, and given the large class size involved, there is virtually no group work or activities. Instruction is teacher dominated, and student involvement is minimal. Memorization of mathematical facts is stressed and students learn mainly by rote. There is ample amount of practice of mathematical skills, mostly without thorough understanding. Students and teachers are subjected to excessive pressure from the highly competitive examinations, and the students don't seem to enjoy their study. (Brimer and Griffin, 1985; Biggs, 1994; Leung, 1995, 2000; Wong and Cheung, 1997; Wong, 1998)

Why is East Asian teaching organized in the ways as described? Why have these seemingly poor and backward instructional practices been able to produce students with high achievement? Do the East Asian countries have a rationale for the way that their teaching is conducted? What are the values implicit behind these instructional practices? In another word, is there a distinctive East Asian theory of mathematics education?

Aren't Theories of Mathematics Education Universal?

[1] Paper presented at a regular lecture at the 9th International Congress on Mathematics Education (ICME-9), Tokyo/Makuhari, Japan, 2 August 2000.

[2] Some education systems referred to in this paper are not countries (e.g. Hong Kong), but for the ease of presentation, instead of saying "countries/systems" every time, the generic term "countries"

In this paper, a theory of mathematics education refers to a set of distinctive features together with an **explicit** set of values or rationale behind those features.

A theory of mathematics education rests on a theory of mathematics learning, and in the literature on learning theories of mathematics, there seems to be an assumption that learning theory is by and large culture independent. All children supposedly go through the four Piagetian developmental stages, and children in all parts of the world construct mathematics concepts out of their existing schema through interacting with their environment. Of course different cultures and environments shape our experiences, giving rise to different schema and different paces in going though the developmental stages. Nevertheless, since we are all human beings, we should follow the same mechanism in the learning process, and although the circumstances differ, we should acquire mathematics concepts in roughly the same way. And as a result, although educational practices in mathematics may differ, the underlying theories or rationales should be universal, just as (it is assumed) mathematics is universal. If the above argument holds, theories of mathematics education should be universal, and a theory of mathematics education for East Asia, even if it exists, should not differ fundamentally from other theories of mathematics education. But is this the case?

Before answering this question, it may be helpful to consider the parallel question of whether mathematics is universal. Most professional mathematicians may maintain so, but research into the different traditions of mathematics in the study of the history of mathematics and the rise of the study of ethnomathematics in recent years have testified to the fact that there are indeed different mathematics in different cultures. So unless we confine the definition of mathematics to the mathematics of the professional mathematicians, the argument for the universality of mathematics is difficult to defend. The argument for universality was simply a Eurocentral view, "cutting off many concrete human-cultural parts and rearranging the remaining conceptual parts into a logical and concise system" (Hirano, 2000). Hirano argued that the perceived universality of mathematics is actually a result of "the fact that mathematics has developed, especially after Descartes in the 17th Century, with the aim of forming a conceptual system in spite of various aspects of its development process".

In a similar manner, if we do not "cut off the concrete human-cultural parts" of mathematics education for the sake of building "a logical and concise system", we will find that features of mathematics education in different cultures also differ, and it is the intention of this paper to argue that the different features are results of different cultural values, hence the potential of a distinctive East Asian identity of mathematics education. The universality of a theory of mathematics education is an assumption rather than a justified conclusion.

The Search for an East Asian Theory of Mathematics Education

By and large, we can say that the East Asian countries share a common culture, namely the Chinese culture (or at least the East Asian countries referred to in this paper are those that share this common culture, countries such as Japan, Korea and Singapore). The Chinese, one of the oldest civilizations in the world, lay strong emphasis on the importance of education, and there is an established Chinese theory or values of education (Leung, 1999). On the other hand, in the history of mathematics, Chinese mathematicians made significant contributions in the field of mathematics, and we can readily identify a set of distinctive features of ancient Chinese mathematics (Leung, 1999). In contrast, although mathematics education has a long history in China (there is records of mathematics education from the time of 2000 B.C.) and there must have been distinctive features in mathematics education, it seems that the Chinese have not organized it into a well-developed theory of mathematics education.

Of course mathematics education as a discipline, unlike the disciplines of mathematics and education, is a relatively young field of study. If a narrow definition of mathematics education is taken, its root can be traced to the emergence of learning psychology at the beginning of the 20th Century. This was exactly the time when the East Asian countries were either colonies of or subjected to heavy influence from Western countries. Instead of developing a theory of mathematics education of its own, educators in East Asian countries have either adopted a Western model of mathematics education or failed to develop any theory of mathematics education at all. Yet even without a theory of its own, teachers in these countries at the classroom level seem to have developed rather distinctive ways of teaching mathematics, as will be described below.

This state of the matter (without an explicit theory of mathematics education yet retaining a distinctive way of teaching mathematics) seems to have served the East Asian countries well. But more and more, educators in these countries are feeling the need to search for an identity of mathematics education of their own. Firstly with de-colonization in some parts of East Asia, there is a need to re-think the theory on which their practices are based rather than merely adopting the theories from their former suzerains. Secondly, with increased contact between East Asia and the rest of the world, East Asian educators find that the Western literature is criticizing exactly the kind of practice that is going on in their classrooms. Yet thirdly and paradoxically, they also find their students out-performing their counterparts in Western countries in comparative studies of mathematics achievement. Lastly, partly because of the high achievement of the East Asian students mentioned above and partly because of the growing interest in Eastern cultures in the West in general, Western countries are beginning to look to the East Asian education systems for solutions to their problems in mathematics education. This cluster of conflicting phenomena prompted East Asian scholars to re-evaluate their traditional cultural values and to build an identity of mathematics education of their own in order to locate themselves in the international scene of mathematics education.

Features of East Asian Mathematics Education

To provoke discussion in this search for an identity, the features of the East Asian mathematics education together with the underlying values in contrast to features and values in the West are presented in terms of six dichotomies below:

1. Product (content) versus process

Mathematics is a body of knowledge arrived at through a certain way of dealing with reality, in particular in dealing with numbers and shapes. The traditional view of mathematics education focussed on acquiring the body of knowledge, but the contemporary Western view stresses getting hold of the ways that the body of knowledge is arrived at. So there has been a trend in recent decades to focus more on the process of doing mathematics (e.g. problem solving, investigations) rather than learning the mathematics content itself. The emphasis in East Asian countries however has been on both the content and the process (e.g. the emphasis on the "two basics" (basic knowledge and basic skills) in China). In fact, the underlying belief is that the content is fundamental. Without content, there is nothing for the process to be applied to.

Underlying this dichotomy is the view on the nature of mathematics: is mathematics essentially a body of knowledge or is it a way of dealing with particular aspects of reality? Mathematics educators from both the East and the West will surely say that it is both, but it is the position on the continuum between the two extremes that divides an East Asian view and a Western view. East Asians believe that their Western counterparts have gone too far towards the process extreme. They are re-affirming the importance of the content of mathematics in the process of learning mathematics.

2. Rote learning versus meaningful learning

The East Asians have always stressed the importance of understanding in learning, yet they do not preclude memorization in the learning process. On the contrary, memorization has always been an accepted way of learning, even when committing to memory things not totally understood (Liu, 1986). If fact, it is hard to tell whether one has "totally understood" or not. Understanding is not a yes or no matter, but a process or a continuum.

Committing to memory without understanding is sometimes referred to as rote learning, and East Asian students have often been criticized as learning by rote. But Wong argued that repeated learning and committing things learned to memory is not the same as rote learning or learning without understanding (Wong, 1998). Biggs (1996) pointed out the difference between the Chinese tradition of "repetitive" learning and the much criticized concept of rote learning in the West, and considered "repetition as a route to understanding" (Hess and Azuma, 1991, quoted in Biggs, 1996; see also Biggs, 1994, Marton *et al*, 1996). Marton (1997) also argued that for the East Asian culture, repetitive learning is "continuous practice with increasing variation" which will lead to deep understanding. It is through the synthesis of memorization and repetitive

learning that the learner discerns the underlying concepts (Dahlin and Watkins, 2000). Memorization, even before thorough understanding, may have an important role to play in learning mathematics.

Underlying this dichotomy is the view on the nature of mathematics learning. The East Asians feel that classifying "memorization as a way of learning" as rote learning without understand is too simplistic a view.

3. Studying hard versus enjoying the study

Pleasurable learning has been a slogan in some Western countries. Yet the traditional view in East Asian countries, especially in China, has been that studying is a serious endeavour, and one is expected to put in hard work and is not supposed to "enjoy" the study (Garvey and Jackson, 1975). Stevenson *et al* (1987) commented that "Asian parents teach their children early that the route to success lies in hard work" (see also Hess, Chang and McDevitt, 1987). And every Chinese is familiar with the many ancient Chinese folk stories about famous figures having had a hard time studying and eventually becoming successful (see for example Huang, 1969). This is in sharp contrast to the attempts in Western countries to simplify what is to be learned for students or introduce different sorts of activities in order to make the learning more pleasurable.

In a sense the East Asians are also trying to derive enjoyment or pleasure out of the study. But it is not the kind of pleasure arising from an easy process of doing mathematics. It is a contentedness derived from having put in hard work and arriving at a deep knowledge of the subject. It is a deeper kind of happiness that the East Asians are aspiring to. It is admitted that it is not easy to derive this deep level of happiness, especially for children at school level. But this is the ideal that East Asians are striving to achieve.

So underlying this dichotomy are different ways of looking at learning itself.

4. Extrinsic versus intrinsic motivation

Educators in the west treasure intrinsic motivation in learning mathematics, and consider extrinsic motivation such as that derived from examination pressure as harmful to learning. Yet an optimal level of pressure is thought to be healthy in East Asian countries. The extrinsic motivation arising out of a competitive examination system and a high expectation on student achievement provides students with an incentive to learn. East Asians think that both intrinsic and extrinsic motivations should be utilised in promoting students' learning of mathematics. Furthermore, the distinction between intrinsic and extrinsic motivations is not clear-cut and may be complementary (Lynn, 1988)

This dichotomy reflects the different views on the motivation for learning and on the nature of human beings. The Western view sees human beings more positively, believing that it is enough to kindle students' interest in mathematics for them to be initiated to learn the subject. The East Asian position does not rule out intrinsic motivation. However, they also believe that as being human, we need some "push" in our learning. An optimal amount of extrinsic motivation, such as a high-stake public examination, will direct students' energy and attention to study and to learn. The difficulty in this dichotomy is of course in determining what is the "optimal" amount. Too often, East Asian countries have gone beyond the optimal level, creating undue pressure upon students, and resulting in a harmful effect. However attaining an optimal amount of extrinsic motivation is still something that is very much valued in East Asia.

5. Whole class teaching versus individualised learning

In the West, individual care is seen as the ideal, and it is only because of financial or other resource limitations that educators resort to large class, whole group teaching. Yet in the Eastern tradition, learning together in a social setting is highly treasured, and this may be related to the "social orientation" (as opposed to individual orientation) of the Chinese (Yang , 1981). For learning in a large group setting, the role model of the teacher is essential, and this results in a "direct teaching to the whole-class" mode in East Asian countries. East Asian educators feel that extreme modes of individual attention such as individualised learning programmes may prove to be harmful because most of the time the students are interacting with the learning materials rather than with the teacher. They lose the chance of discussing with or observing/listening to the teacher, thus losing the opportunity to model upon the teacher.

This dichotomy points to a different understanding of the nature or the role of the teacher. Role modelling of the teacher is extremely important in the East Asian culture. Of course whole class teaching is not a necessary result of role modelling. But if teaching involves mainly providing a role model, then class size becomes less important. The crucial point is what kind of teacher is needed and what role the teacher is playing in the teaching and learning setting rather than how big the class size is. This leads to the last dichotomy below.

6. Competence of teachers: subject matter versus pedagogy

With the exponential growth of knowledge and their easy access through the internet, it is believed that the teacher is no longer expected to be competent in

the subject area. Her role should be that of a facilitator of learning rather than the source of knowledge. This implies that what the teacher needs is primarily competence in pedagogy, i.e. the skill in helping students to acquire the knowledge that the teacher may or may not possess. In contrast, the image of the teacher in the East Asian tradition is still that she is an expert or a learned figure (a scholar) in mathematics. Expertise in pedagogy is important, but more important is a good grasp of the subject matter. Recent studies have shown that actually without a thorough understanding of the knowledge, it is not possible to invoke the appropriate pedagogy (Ma, 1999; Fung, 2000). The East Asians believe that a teacher should be primarily a scholar before she is able to play the role of a facilitator of learning.

This dichotomy, like the last one, points to a different understanding of the role of the teacher. It is also related to a different understanding on the nature of mathematics as discussed in 1. above. Is the teacher primarily a scholar, a facilitator, or both? Again mathematics educators from both East and West will surely say that it is both, but East Asian educators will further affirm that it is not possible to be a facilitator without being a scholar.

Student Centre, Teacher Centre or Knowledge Centre?

As can be seen above, the distinctive features of the East Asian mathematics education involve underlying cultural values which touch upon the nature of man, the nature of mathematics, the nature of teaching and learning, and an understanding on the role of the teacher. A theory of mathematics education in East Asia must be built upon these fundamental East Asian views and values.

The above dichotomies point to fundamentally different views on who or what should the centre in the teaching and learning process be. Student-centredness is the basic tenor in Western education theories, yet East Asian educators are affirming the importance of the teacher and the subject matter. This tripartite emphasis on the student, the teacher and the subject matter is perhaps the essence of an East Asian identity in mathematics education.

The Impact of Modern Technology

Looking into the future, the recent advances in information and communication technology (ICT) have added a further complication in this search for an identity. ICT has brought about the so-called knowledge society, an era which sociologists

termed late modernity. According to Giddens (1991), there are three "core ideas" that characterize late modernity. They are (1) the globalization of access to communication and knowledge, (2) the "de-traditionalization" of social life, and (3) the application of knowledge to social life. Most relevant to our current discussion is Gidden's idea of "de-tradionalization" of social life, by which he means that "distant resources of information may exert more influence upon our behavior than traditional sources associated with the nation, region, or locality. Social life is consequently disembedded from traditions as globalization of knowledge erodes local values and habits." This characteristic of late modernity is actually a direct result of the other two characteristics. Given the globalization of access to communication and knowledge and the wide applications of knowledge to social life, people in late modernity have the capability to choose their social identities from the international pool of information and values. This is in contrast to the past when their sense of identity was basically determined by the cultural traditions in their nation or locality. Given this scenario, will different cultures converge to one international norm in the future? Will divisions in social identities according to geographic regions and cultures disappear eventually as a result? If the answer is positive, it may no longer be meaningful to talk about an East Asian identity of mathematics education, or indeed any traditions of mathematics education at all.

ICT will undoubtedly facilitate worldwide exchange of ideas and values, and will exert pressure for different countries to conform to an international norm, but whether social and cultural boundaries will eventually disappear is extremely doubtful. Even if an international culture were eventually to emerge, this culture will not arise out of a vacuum but has to be derived from existing constituent cultures. In order for the East Asian tradition to be able to contribute better to this worldwide exchange of ideas and values, it is imperative for East Asian countries to seek an identity and build up a theory of mathematics education of its own.

Conclusion

For East Asian educators, it is hoped that this paper contributes one step in the search for an identity in mathematics education. By characterizing the distinctive features of mathematics education in East Asia and analyzing the values behind the practices, it is hoped that this paper will help in provoking thoughts and discussions as East Asian educators strive to search for an identity of mathematics education of their own. When faced with criticisms, East Asian educators should not be apologetic too soon. One should always humbly learn from traditions other than one's own, but at the same time it should be realized that different practices are based on different deep-rooted cultural values and paradigms, whether explicit or implicit, that are built up in centuries. In considering adopting the practices from a different cultural tradition, one has to thoroughly analyze the underlying values to see whether they are compatible with the values in one's own culture. Wholesale adoption rather than adaptation is usually not desirable.

The same warning applies to Western countries in their effort to learn from the East Asian countries (e.g. the suggestion in some states of the United States to adopt Singaporean textbooks). Of course the other extreme of judging the instructional practices in East Asian countries from the point of view of Western theories of mathematics education is something that needs to be avoided as well.

The purpose of this paper however is not to justify the practice of mathematics education in East Asian countries. It is not meant to argue that since students in East Asia achieve well in mathematics, whatever their classroom practice must be good. The intention of the paper is to show that there exist distinctive features of mathematics education in East Asia, and that those features are expressions of distinctive underlying cultural values. In another word, there exists an East Asian identity in mathematics education, and an awareness of that identity should contribute in a more meaningful way to a sharing of best practices with other cultural traditions.

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