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Cultural Diversity and International Education: The Case of Ethnomathematics

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Panel abstract:

How do we preserve heterogeneity if we try to homogenize the world? How do cultural values in the West, Asia, and the Middle East affect their view of human rights and global social justice? What happens when introducing a Western school system to non-Western cultures? How does fostering values of global civic responsibility at universities challenge local civic values?

Chair: **Dr. Josiah Tlou** (Director of the Center for Research and Development in International Education, School of Education, Virginia Tech)

Co-panelists:

- **Dr. Ioannis Stivachtis** (Director of the International Studies Program, Department of Political Science, Virginia Tech): "The International Order in a Multicultural World: Challenges for the 'International' University"
- **Xi Chen** (Department of Political Science, Virginia Tech): "Human Rights, Global Social Justice and Cultural Diversity: Myth or Reality? The Case of China"
- **Dr. Scott G. Nelson** (Department of Political Science, Virginia Tech): "A Normative Approach to Internationalizing Political Science Curricula".

Dahl paper abstract:

The purpose of this paper is to discuss if the teaching of mathematics implies a cultural adaptation to Western culture. Ethnomathematics is a different mathematics practised among local cultural groups. The present mathematics has, during the last 300-400 years, been developed in Europe, which has influenced it with Hellenistic values. Introducing mathematics in third world countries to help economic development and participation often brought new ways of measurement and thinking, while the old died out. Is there a Catch-22 between cultural preservation and economic development?

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1. Introduction

If mathematics is an objective science about absolute truths, why then have different cultures not developed the same kind of mathematics as the school mathematics that we may know from our school books? Is there only one mathematics? Are the different types of mathematics various versions of ‘mathematics’ and not logically mutually exclusive? Does the sum of angles have to be 180 degrees? Why not 100? Do triangles exists or does the fact that one can see triangles reflect something in one’s culture?

The concept of ethnomathematics discusses these questions and in this paper I would like to begin a discussion of mathematical knowledge; a school topic that is by most people regarded as essential for both preserving technological economic growth in the developed world as well as a key topic to foster growth in the developing world.

1.1 What is Ethnomathematics?

The definitions on ethnomathematics go from “Ethnomathematics is the study of mathematical ideas of nonliterate peoples” (Ascher & Ascher, 1986, p. 125) to Bishop’s idea that ethnomathematics is “a more localised and specific set of mathematical ideas which may not aim to be as general or as systematised as ‘mainstream’ mathematics” (1990, p. 53). Mellin-Olsen understands ethnomathematics as: “It is the way people outside the established society of mathematicians use the subject” (1987, p. 21). D’Ambrosio uses the word ‘ethno’ relative to a group of people with the same cultural traditions and identity, not necessarily in relation to a race. Ethnomathematics is here “the mathematics which is practised among identifiable cultural groups, such as national-tribal societies, labour groups, children of a certain age” (1985, p. 45). Skovsmose interpret D’Ambrosio’s definition on ethnomathematics as the hidden mathematics competency made explicit (1990, p. 117). Vithal argues that ethnomathematics gives a more comprehensive description of mathematical knowledge since it acknowledges mathematical ideas and activities from all peoples (1992, p. 14). Borba’s writes about the importance of language in mathematics:

> *Mathematical knowledge expressed in the language code of a given socio-cultural group is called ‘ethnomathematics’. In this context, ‘ethno’ and ‘mathematics’ should be taken in a broad sense. ‘Ethno’ should be understood as referring to cultural groups, and not to the*

anachronistic concept of race; 'mathematics' should be seen as a set of activities such as ciphering, measuring, classifying, ordering, inferring and modelling.
(Borba, 1990, p. 40)

I am not going to discuss these definitions' alikeness and differences further but rather state that various cultures develop mathematics and that the (Western) mathematics we know from school books etc. is not the only one. However, as the quote of Borba mentioned above suggest that underneath the different 'ethno's' versions of 'mathematics' is something that might be called the real mathematics, namely the set of activities such as measuring, ordering, etc.

2. Western mathematics and ethnomathematics

I will here firstly discuss the mathematics-like systems developed in non-Western cultures, secondly if the Western mathematics has been developed in Europe alone or also by contributions from other cultures and countries. I will use the concept of academic/school/Western mathematics as synonyms.

2.1 Mathematics in other cultures

Joseph writes that "Resent case studies of India, China and parts of Africa ... seem to indicate the existence of scientific creativity and technological achievements long before the incursions of Europe into these areas" (1990, p. 2). Bishop writes (1990, p. 52) that in Papua New Guinea there has been documented almost 600 systems of arithmetical notation that not all have base 10. Besides finger counting there has been documented a use of "body counting" where they point at a specific part of the body and use this body part's name as the name of the number. Numbers have also been registered as knots on a rope and as carvings on wooden or stone tables. Gerdes has shown an alternative construction of Euclidean geometry by looking at woven knots from Mozambique: "The square button, woven out of two strips, hides some remarkable geometrical and physical considerations" (1988, p. 149).

Mathematics is also reflected in the culture's language, and vice versa. For instance in Papua New Guinea, which is an area of many mountains, the language has different words for different degrees of steepness, whereas it is very difficult to describe something that is vertical (Bishop, 1988b, p. 28). This makes it difficult for them to work with mathematical concepts such as the system of co-ordinates, which involves a horizontal ax. Also on Papua New Guinea, "'The local unit of distance is a day's travel which is not very precise.' ... (Comparing volume of rock with volume of water): 'This kind of comparison doesn't exist, there being no reason for it'" (Bishop, 1988b, p. 34). A mathematical or science lesson here has to start even further back than for children being raised in a Western country where for instance precise measurements (down to millimeters and seconds) is something natural to almost any child. Bishop writes that indo-European languages:

> *seem almost obsessed with logic, with forming complex propositions and with linking chains to these. Moreover as Bridgman (1958) says 'It begins to look as though formal logic as we know it, is an attribute of the group of Indo-European languages with certain grammatical features.' ... It is the case that other languages, from other language groups, will have their own grammatical features with their on logics 'as they know them.'*
> *(Bishop, 1988a, p. 51)*

Languages from other cultural groups have other grammatical rules and features. Bishop also mentions the language of the Kpelle from Liberia and an investigation that among other things focused on disjunction. The result of the investigation was that the Kpelles had a "more precise way of expressing disjunction. In English the word 'or' has both an inclusive and an exclusive meaning and this difference in the language resulted in the Kpelle subjects doing rather better than their American counterparts on an experimental test concerned with understanding disjunction" (Bishop, 1988b, p. 52).

An example to illustrate the difference between school mathematics and local, or non-school, mathematics can be seen in Carraher et al. (1985) who investigated Brazilian street children's informal mathematical knowledge by first testing them in their natural working situation on street corners and then formal tests in a context similar to the school setting. The children used different routines in the two settings. An example (p. 26-27):

Informal test

Customer: What should I have to pay for six kilos? (of watermelon at Cr $ 50.00 per kg.)
Child: [Without any appreciable pause] 300.
Customer: Let me see. How did you do it so fast?
Child: Counting one by one. Two kilos, 100. 200. 300.

Formal test

Test item: A fisherman caught 50 fish. The second one caught six times the amount of fish the first fisherman had caught. How many fish did the lucky fisherman catch?
Child: (Writes down 50 • 6 and 360 as the result; then answers) 36. Examiner repeats the

problems and the child does the computation again, writing down 860 as result. His oral response is 86.

Examiner: How did you calculate that?

Child: I did it like this. Six times six is 36. Then I put it there.

Examiner: Where did you put it? (Child had not written down the number to be carried.)

Child: (Points to the digit 5 in 50). That makes 86 [apparently adding 3 and 5 and placing this sum in the result].

Examiner: How many did the first fisherman catch?

Child: 50.

This does not mean, that the school mathematics would not have given the correct answer to the problem, had the children understood the school mathematics methods, but it illustrates that the procedures of street-mathematics are different from the school mathematics procedures, and also that, for some reason, the street procedures makes more sense to the students, and they also works, at least with this type of mathematics/arithmetic. Related to this result is that other research has shown that children perform better when problems are presented in their native language rather than in English (Adetula, 1990).

It therefore seems that other cultures than the Western European have developed mathematics (or arithmetic) that is either different from the Western mathematics or where for instance “the geometrical thinking [is] culturally frozen’ in the square-woven buttons” (Gerdes, 1988, p. 151). However, particularly regarding the latter, I see it as a problem that this type of ethnomathematics has been defined, or searched for, from a Western mathematics perspective – it is not defined in itself. Regarding the example from Papua New Guinea, this is recognised by comparison with Western mathematics.

One can therefore conclude that cultural groups outside the Western Europe, perhaps implicitly in other forms of knowledge, have developed mathematical experiences and knowledge. One can discuss if one can even talk about mathematical knowledge if it is only indirectly present in some square-woven buttons. It might be a coincidence that the patterns fit with Euclidean geometry. The reason why these patterns fit might be that the observer thinks in Euclidean geometry and therefore is able to recognize these patterns – he sees what he can/want to see, so to speak. Gerdes furthermore defines one mathematics on the basis of another whereby he indirectly has stamped the Euclidean mathematics as the right mathematics. Furthermore one might argue that this form of perhaps tacit knowledge is not real knowledge but it more a case of the “Jourdain effect”, where a teacher reveals to Mr. Jourdain (from Mollière’s 1670 play Le Bourgeois Gentilhomme) that Mr. Jourdain speaks in prose, without Mr. Jourdain knowing what prose is (Brousseau, 1997, p. 25-26). I will therefore argue that the people in question from Mozambique have not developed a mathematics as the Western because it is hidden. However, this does not mean that I do not believe that there exists other mathematics in other cultures. But I think that one can better argue for this based on the example of the non-base 10 systems of arithmetical notation and the body counting system. These examples do also have similarities to Western mathematics, but it is still explicit knowledge and it also has some features that are different from Western mathematics. As Bishop writes: “The thesis is therefore developing that mathematics must now be understood as a kind of cultural knowledge, which all cultures generate but which need not necessarily ‘look’ the same from one cultural group to another. ... Mathematics is a pan-human phenomenon” (1988a, p. 180), and furthermore that instead of seeing these various mathematics as being different, they are in a sense “dialects” of the same mathematics; i.e. they are all a system of logical focused on measurement, ordering, counting etc., and there is transferability between the systems since for instance even a non-base 10 system of arithmetic can be described, and recognized, by Western mathematics.

2.2 It is not “our” mathematics

How has academic mathematics been developed? Mathematics text books are full of theorems of Euclid, Pythagoras, Leibniz, Gauss, Cantor, Fermat, Weierstrass etc., who were all Europeans. This might cause the students to perceive the academic mathematics as being European mathematics. According to Joseph, the traditional view of the development of mathematics “is seen taking place in two sections, separated by a period of stagnation lasting for over a thousand years: Greece (from about 600 BC to AD 400), and post-renaissance Europe from the sixteenth century to the present day. The intervening period of inactivity was the ‘Dark Ages’” (1990, p. 4). However, history shows that our mathematics is not just of European origins. For instance the base 10 numbers came from Arabia, while the zero came from India. This is among other things seen from “the full acknowledgement given by the ancient Greeks themselves of the intellectual debt they owed the Egyptians” (Joseph, 1990, p. 5). Furthermore there has been found traces of “a high level of mathematics practised in Mesopotamia and in Egypt at the beginning of the second millennium BC” (Joseph, 1990, p. 6). There were therefore big centers for the development of mathematics various places in the world before there was a development in Greece. “[A]ccording to some Greek sources, Pythagoras had ventured as far afield as India in his search for knowledge” (Joseph, 1990, p. 18). During the so-called ‘Dark Ages’, there was a lot of development in the Arab world:

> *Scientific knowledge which originated in India, China, and the Hellenistic world was sought out by Arab scholars and then translated, refined, synthesized and argumented at different centres of learning, starting at Jund-i-Shapur in Persia around the sixth century (even before the coming of Islam), and then moving to Baghdad, Cairo, and finally to Toledo and Córdoba in Spain, from where this knowledge spread into Western Europe.*
> *(Joseph, 1990, p. 10)*

The academic mathematics is therefore not solely Western: “modern mathematics, as we know it today is the result of the cumulative effort of diverse peoples over thousands of years” (Vithal, 1992, p. 21). However, the mathematics that we have today has during the last 300-400 years been developed in Europe (Pedersen, 1978). I also disagree with Joseph in his view that academic mathematics is mostly regarded as European; many university studies of mathematics have as part of the program, a course in the history of mathematics, which deals with the whole story of mathematics (for instance Virginia Tech).

2.3 The relationship between Western mathematics and ethnomathematics

Since mathematics therefore has been developed through history by contributions from different cultures, one might assume that academic mathematics is therefore understandable to all peoples. However, the later 300-400 years of European development has influenced its character. For instance is the academic Western mathematics the only mathematics that has become decontextualised and then become its own context. Therefore one can now develop new mathematics alone on the basis of existing mathematics. This decontextualization is influenced by Hellenistic thinking characterized by abstract thinking and generalizations. This type of decontextualization reflects European culture and thinking of the nature of knowledge, mainly Platonic and Hellenistic emphasis on abstract thinking, generalizations, and contempt for the world of the senses. This is seen in the academic mathematics’ use of abstract phenomenon and treatment of them as if they really existed and it is reflected in the mathematical language with names such as “Natural numbers” and “Real numbers”. For instance in a textbook on mathematical analysis it is written in the introduction to a chapter:

> *A large part of the previous chapter dealt with ‘abstract’ sets, that is, sets of arbitrary objects. In this chapter we specialize our sets to be of real numbers, sets of complex numbers, and more generally, sets in higher-dimensional spaces. ... Thus, we speak about sets of points on the real line, sets of points in the plane, or sets of points in some higher-dimensional space.*
> *(Apostol, 1974, p. 47)*

This introduction gives the reader the impression that now we will start working with "real" numbers and sets whereas previously they had worked with abstract sets.

Therefore Bishop (1990, pp. 53-56) argue that local mathematics has been run over by "Western mathematics", which he calls Western imperialism. Trade, administration, and education are areas that according to him indirectly through academic mathematics has become subject to cultural imperialism. In regard to trade, Western ideas of for instance length, area, volume, weight, time, and money been forced on the locals. The local units became either westernized or died out. New thought systems that were partly alien to the locals, or irrelevant, were forced on the locals. To administer a large amount of people made it necessary to use the academic number system. This is because the major parts of number systems in the world are finite and limited and therefore impossible to use for treat a larger sum with. Another example might be seen in the Greenland language and mathematics which only have the numbers 1-20, the rest from there are Danish. This is according to Bishop cultural imperialism, through the back door. Some argue that when the children come to school "it causes some children to loose the skills that they already had ... Other children loose confidence in their own commonsense because the school reality is so different from real life" (Vithal, 1992, p. 60). This means that the academic mathematics seems alien and incomprehensible to the students and furthermore the students abandon or forget the skills that they already had.

This also has an effect for the school systems that the colonies developed, where the (globally developed) mathematics sometimes became incomprehensible to some locals. Bishop gives an example of a mathematics problem from Tanzania: "Reduce 207, 042 farthings; 89,761 half-pence; 5,708 ½ shillings to £". According to him, a problem like this is meaningless to the locals since it does not refer to anything from their world and that the students therefore were "educated away from their culture and away from their society" (Bishop, 1990, p. 56). The issues with the problem are not semantic or syntactical, but rather pragmatic and metaphysical which means that if one does not know the context wherein this question would be meaningful and also do not know the deeper ideas behind the question, this alienates one from the question. This means that the problem is not simply solved by looking up the money system in a table, but even if a student could do it, and get the right answer, it still would not be meaningful to them. It would be correct, but not "right". I would however comment that, even though Bishop has a point here, this particular mathematics problem might even have caused problems for students in Great Britain who might have found it difficult to really find "meaning" in this problem. Hence, it just as much a general pedagogical problem of that time.

2.4 Mathematics IS ethnomathematics

Mathematics did not start at a specific point in history. It evolved through history and various cultures have contributed, and 'mathematising' in some way or other is present in all cultural groups (Burton, 1999; Struik, 1987). As Bishop writes: "we can now see that the *symbolic technology* of mathematics is continually evolving in all cultures and in all societies as a result of ... activities carried out separately, and in interaction" (1990. p. 56). The notion of ethnomathematics has the tendency to "freeze" a mathematics and a culture but mathematics is a product of many cultures. Mathematics is not something that has been developed solely in an "identifiable group" as D'Ambrosio puts it. It is a product of other cultures mathematics (that gave one inspiration) as well as a response to specific needs within a culture. Therefore one cannot speak of "a ethnomathematics" but rather that mathematics IS ethnomathematics. This means that any ethnomathematics and any mathematics is developed as part of a cultural development. The ethnomathematics changes just as culture changes. I will however still keep the notion of academic mathematics to refer to the decontextualised (school)mathematics that many of us have met at school and university.

3. (Eternal) cultural preservation and/or economic development?

From one point of view this cultural diversity of mathematics is an enrichment since it illustrates a range of possible ways of making measurement and account of the world. It is also linked to the cultures as a whole as well as linked to the various languages of the different peoples. One can also interpret various colonial attempts to export "our" mathematics to as cultural imperialism whereby cultures disappear. However, one might also argue that to really help the economic development of developing countries, they do need "Western" mathematics. To be able to participate in the economic development, people need to learn the more abstract mathematics – like people in Greenland needed to be able to count to more than 20 – since their society developed and only having the numbers 1-20 became unhelpful. There seems to be a Catch-22 between cultural preservation, mathematical and cultural heterogeneity, economic poverty – and - economic development, mathematical and cultural homogeneity, global social development. Some might argue that the economic development will further eliminate their cultures. However, I will argue, that this might deprive them of the possibilities that “we” have, such as good hospitals so that very few mothers do not die giving birth, we do not have to suffer enormously pain when we visit the dentist, we have Internet, a freezer etc. etc. Giving them “Western mathematics” might create the possibility of an economic development where these things can also become theirs. One could also argue that the academic mathematics for them could be a tool to help them to develop economically and then, perhaps, this development would make it possible for them to preserve their culture – a developed version of their culture, but a development that they decide on.

This also applies to people from outside Europe immigrating to Europe. One might argue that for them to learn mathematics, hence giving them a chance to participate in the societies and the economy, they need to learn the European mathematics, as it is today. Hence they probably need to be enculturated into European-mathematical thinking or at least become “bilingual” in the different mathematical languages. Being bi-lingual would also be a way for them to both preserve their original identity as well as fully participate in the society and world economy.

Alternatively, one could argue that perhaps one could also develop their local mathematics to become as useful to research and science development as the present mathematics. However that might in itself destroy the nature of that piece of mathematics since this would demand a decontextualization that many of these local mathematics have not got. Also, from a practical/pragmatic point of view, it might take decades/centuries to develop their local mathematics into a body of knowledge that is useful for science, research and economic development, and while this development takes place, these countries and peoples fall even more behind the developing countries in a world that seems to develop even faster every day.

In this connection one also needs to consider the fact that a culture always changes and never is completely fixed in time. One can therefore argue that an export of academic mathematics and the cultural changes it may bring about, would just be a natural development/change. Furthermore, about bringing the local mathematics into the classroom, Civil and Andrade write:

> *our goal is not to ‘take’ the home-mathematics and bring it into the classroom, transform it in one way or another and make it ‘conform’ to the school-mathematics. … the pedagogical transformation of home mathematics into school mathematics presents several challenges (e.g. risk of ‘watering down the school math’; using home mathematics as an artificial, even false context; trivializing the home mathematics). But more importantly, if our goal were to take the home mathematics and ‘transform’ it into school mathematics, we might be missing the point, namely the richness in the diversity of aims and values behind the different forms of mathematics.*
> *(Civil & Andrade, 2002, p. 166)*

Let us enjoy the diversity and beauty of mathematics as expressed in numerous ways by different cultures. Let this be a way for us to learn more about the nature of mathematics. But also, let us be practical and use the abstract globally developed mathematics as a way to create economic growth and development where it is most urgently needed.

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